Installation, Operation and Maintenance Manual	IOMM VFD-2
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Variable Frequency Drives

Air-Cooled, LiquiFlo™ and LiquiFlo 2.0™

For Centrifugal Chillers

With MicroTech 200™ or MicroTech II™ Control

McQuay® Air Conditioning

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Manufactured in an **ISO Certified** facility

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DANGER

Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

DANGER

DC bus capacitors retain hazardous voltages after power has been disconnected. After disconnecting input power to the unit, wait five (5) minutes for the DC bus capacitors to discharge, and then check the voltage with a voltmeter to ensure the DC capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

CAUTION

The user is responsible for conforming to all applicable local, national and international codes. Failure to observe this precaution could result in damage to, or destruction of the equipment.

WARNING

The drive contains printed circuit boards that are static-sensitive. Anyone who touches the drive components should wear an anti-static wristband. Erratic machine operation and damage to, or destruction of, equipment can result if this procedure is not followed.
Failure to observe this precaution can result in bodily injury.

Introduction

This manual covers Air-Cooled, LiquiFlo (LF) and LiquiFlo 2.0 (LF 2.0) VFDs on centrifugal chillers with MicroTech 200™ or the newer MicroTech II™ controllers. Many issues are the same for both and are treated in common. Where differences occur, information will be designated as being for a specific VFD or controller model.

The above three types of VFDs have four family designations as show in Table 1 and Table 2. Each of these VFD families has a separate section in this manual. There is considerable overlap in programming methods and general operation of the drives, but they are in separate sections to avoid confusion. The beginning page number for each control section in the manual is noted in the tables.

Table 1, Model Sizes, Air-Cooled/LiquiFlo

L=Shipped loose, **M**=Mounted, **A**=Air-cooled, **W**=Water-cooled

VFD Model	VFD Family Designation	Page Location	Max. Amps	Cooling	Optional Line Reactor (Note 1)	
					Size	Amp Rating
VFD 009LA	SP 600	Page 57	87	Air	RC	100
VFD 009MA			87	Air	RC	100
VFD 012LA			114	Air	R1	130
VFD 012MA			114	Air	R1	130
VFD 015LA			142	Air	R2	160
VFD 015MA			142	Air	R2	160
VFD 017LA			164	Air	R3	200
VFD 017MA			164	Air	R3	200
VFD 023LA			225	Air	R4	250
VFD 023MA			225	Air	R4	250
VFD 024LA	PF700H	Page 77	237	Air	RY	STD.
VFD 024MA			237	Air	RY	STD.
VFD 028LA			273	Air	RY	STD.
VFD 028MA			273	Air	RY	STD.
VFD 047LW	LF	Page 90	414	Water	RD	500
VFD 047MW			414	Water	RD	500
VFD 060LW			500	Water	R7	600
VFD 060MW			500	Water	R7	600
VFD 072LW			643	Water	R8	750
VFD 072MW			643	Water	R8	750
VFD 090LW			890	Water	RM	900
VFD120LW			1157	Water	R9	1200

NOTES

1. Line reactors are optional on all sizes except Models VFD 024 and 028, where they are included as standard.
2. Electrical characteristics: 380/460 VAC ±10%, 3 phase, 50/60 Hertz, ±5 Hz.
3. Optional line reactors are 3% impedance.

Table 2, Model Sizes, LiquiFlo 2.0

VFD Model	VFD Family Designation	Page Location	Max. Amps	Cooling
VF 2037	LF 2.0, Frame 3	Page 57	368	Water
VF 2055			553	Water
VF 2080	LF 2.0, Frame 4		809	Water
VF 2110			1105	Water

WSC and WDC single and dual compressor, and WCC dual compressor chillers can be equipped with Variable Frequency Drives (VFD). A VFD starts the compressor motor and then modulates the compressor speed in response to load, evaporator pressure, and condenser pressure, as sensed by the chiller microprocessor. Despite the small power penalty attributed to the VFD internal losses, a chiller can achieve outstanding overall efficiency by using a VFD. VFDs are effective when there is a reduced load, combined with a low compressor lift (lower condenser water temperatures), dominating the operating hours.

The traditional method of controlling centrifugal compressor capacity is by inlet guide vanes. Slowing down the compressor, thereby reducing the impeller tip speed, can also reduce capacity. However, sufficient impeller tip speed must always be maintained to meet the chiller's discharge pressure requirements. The speed control method is more efficient than guide vanes by themselves.

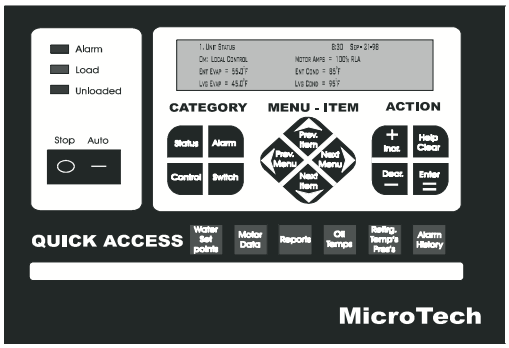
In actual practice, a combination of the two techniques is used. The microprocessor slows the compressor (to a programmed minimum percent of full load speed) as much as possible,

considering the need for sufficient tip speed, to make the required compressor lift. Then the guide vanes take over for further capacity reduction. This methodology provides the optimum efficiency under any operating condition.

Inlet guide vanes control compressor capacity based on a signal from the microprocessor, which is sensing changes in the leaving chilled water temperature. The guide vanes vary capacity by changing the angle and flow of the suction gas entering the impeller. The impeller takes a smaller "bite" of the gas. Reduced gas flow results in less capacity. Compressors start unloaded (guide vanes closed) in order to reduce the starting effort. A vane-closed switch (VC) signals the microprocessor that the compressor vanes are closed.

VFDs can be found on centrifugal chillers with the older MicroTech 200 controller (sometimes referred to as MicroTech I or just plain MicroTech) or the newer MicroTech II™ controller. The two MicroTech controller versions are easily differentiated as shown below. The MicroTech II panel shown below is the initial version known as Panel 1. Panel 2, shown on page 50, replaced it in mid-2005.

MicroTech 200 Control Panel



MicroTech II Operator Interface Panel 1

Operation and adjustment of the VFD involves settings on both the VFD itself and also to the chiller controller, either MicroTech 200 controller or MicroTech II controller. This manual consists of a section relating to VFD operation common to both chiller controllers and also separate sections for the settings specific to either of the chiller MicroTech controllers.

NOTE: VFDs are programmed differently in the factory for 50 and 60 hertz applications. It is prudent to verify this by checking the settings sticker in the unit and the actual unit settings using the Reliance manual shipped with the VFD unit as a reference.

Environmental Conditions

Operating Temperature (inside NEMA 1 enclosure)	32° to 131°F (0°C to 55°C)
Ambient Temperature (outside NEMA 1 enclosure)	32° to 104°F (0°C to 40°C)
Storage Temperature (Ambient)	32° to 131°F (0°C to 55°C)
Humidity	5% to 95% (non-condensing)

AC line distribution system capacity shall not exceed 85,000 amps symmetrical available fault current.

Harmonic Distortion

Harmonic distortion, the effect that any variable frequency drive has on the electrical system supplying it power, is a consideration on most applications and is discussed in detail in Catalog Starter, which can be obtained from the local McQuay sales office or on www.mcquay.com.

The VFD will not generate damaging voltage pulses at the motor terminals when applied within 500 feet of each other. The VFD drive complies with NEMA MG1 section 30.40.4.2, which specifies these limits at a maximum peak voltage of 600 volts and a minimum rise time of 0.1 microseconds.

All VFDs require cooling. Models VFD 019 and VFD 028, rated at 273 amps or less, are air-cooled. All others are water-cooled.

Factory-mounted, water-cooled VFDs have VFD cooling water combined in the factory with the compressor oil cooling system.

Freestanding water-cooled VFDs require field-installed chilled water supply and return piping for the VFD. Models VFD 090 and 120 and all LF 2.0 models have an intermediate cooling module, field installed, between the cooling source and the VFD.

Water-cooled VFD's have a liquid-cooled heatsink assembly enabling liquid cooling of the drive though a single inlet and outlet connection point.

There is a temperature-regulating valve located in the drive. It must be set to maintain 95°F (35°C) leaving coolant temperature. This is necessary to prevent condensation from forming in the heatsink. Minimum entering coolent temperature is 40°F (4.4°C).

Air-Cooled/LiquiFlo (LF), Standard Features

- Electronic overload circuit designed to protect an AC motor, operated by the VFD output, from extended overload operation on an inverse time basis. This electronic overload is UL and NEC recognized as adequate motor protection. No additional hardware, such as motor overload relays, or motor thermostats are required.
- An LED display that digitally indicates:

Frequency output	Input kW	DC bus voltage
Voltage output	Elapsed time	Motor RPM
Current output	Time stamped fault indication	

- The VFD is capable of maintaining operation through power dips up to 10 seconds without a controller trip, depending upon load and operating conditions. In this extended ride-through, the drive uses the energy generated by the load inertia of the motor as a power source for electronic circuits.
- An isolated 0-20mA, 4-20mA, or 0-4, 0-8, 0-10 V analog speed input follower.
- An isolated 0-10V or 4-20mA output signal proportional to speed or load.
- Standard I/O expansion interface card with the following features:
  - Four isolated 24VDC programmable digital inputs
  - One frequency input (0 to 200Hz) for digital control of speed or trim reference
  - Four programmable isolated digital outputs (24 VDC rated)
  - One Form A output relay rated at 250 VAC or 24VDC
- Two NO/NC programmable output relays rated at 250 VAC or 24 VDC
- The VFD includes the following standard protective circuit features:
  - Output phase-to-phase short circuit condition
  - Total ground fault under any operating condition
  - High input line voltage
  - Low input line voltage
  - Loss of input or output phase
  - External fault (This protective circuit will permit wiring to a remote normally closed equipment protection contact to shut down the drive.)

LiquiFlo 2.0 (LF 2.0), Standard Features

- NEMA 1 enclosure with hinged door.
- Package includes a circuit breaker with shunt trip with AIC rating of 65,000 amps.
- Full motor voltage is applied regardless of the input voltage.
- Efficiency at rated load and 60 hertz is 97%.
- Drive thermal overload is 110% for 60 seconds in volts per hertz mode and 150% for five seconds in sensorless vector mode.
- Achieves IEEE519 using actively controlled IGBT front-end maximum of 5% THD.
- 0.99 power factor at full load and provides power factor correction at lighter loads.
- IGBT switching: 2kHz carrier frequency.
- The entire drive package is UL/CUL listed.
- Optional multi language LCD keypad.
- Power line dip ride through capability for up to 10 seconds.
- Adjustable auto restart (number of restarts and time delay between attempts are selectable.) Display indicates when controller is attempting to restart.
- Control power transformer for chiller unit controls

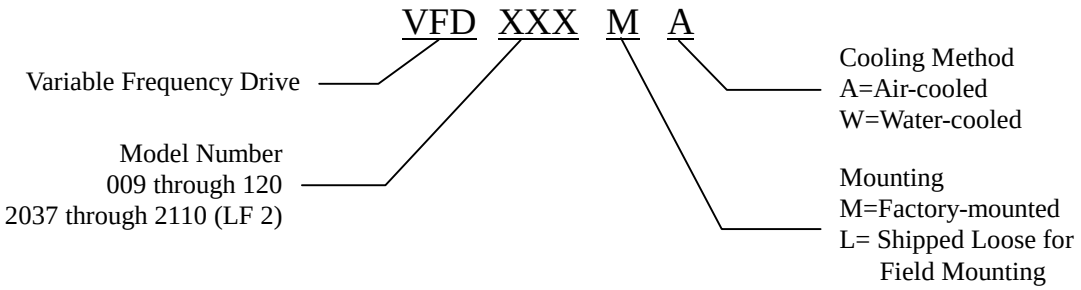
Codes/Standards

- VFDs are UL 508 listed
- VFDs are designed to comply with the applicable requirements of the latest standards of ANSI, NEMA, National Electric Code (NEC), NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, CE 96.

Quality Assurance

- Every VFD is functionally tested under motor load. During this test the VFD is monitored for correct phase current, phase voltages, and motor speed. Correct current limit operation is verified by simulating a motor overload.
- Scrolling through all parameters verifies proper factory presets. The computer port also verifies that the proper factory settings are loaded into the drive.
- Every VFD's heatsink is tested to verify proper embedding of the tubing for flow of coolant liquid. Thermal tests are performed on the VFD to verify that the cooling occurs within the correct temperature range.

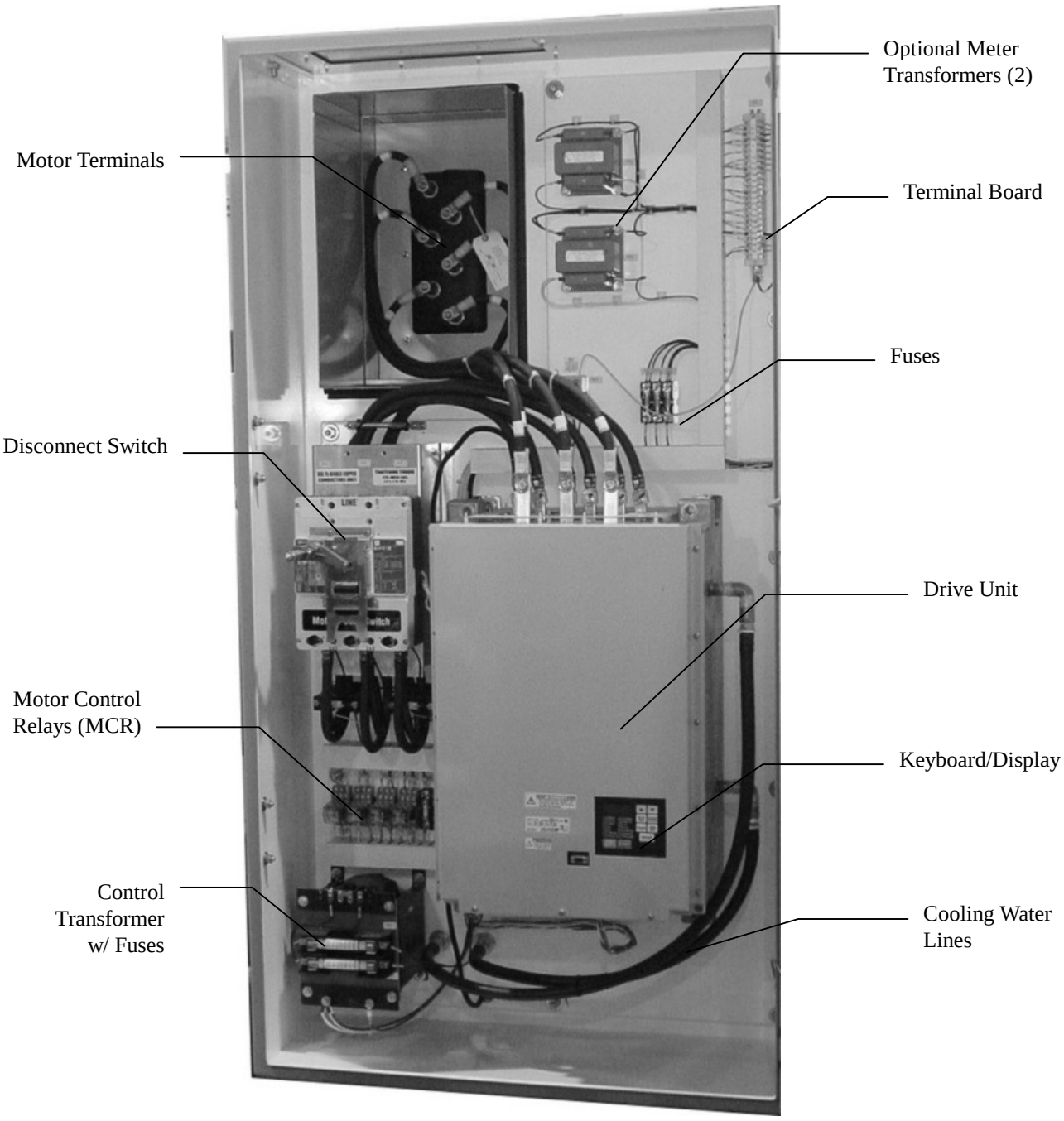
A-C/LiquiFlo, Nomenclature



LiquiFlo 2.0, Nomenclature

Since all LF 2.0 models are field-mounted and water-cooled, there are no characters after the Model Number, typically VFD 2037.

Figure 1, LiquiFlo, Internal Components, Factory Mounted, Water-Cooled Model



Definition of Terms

Acc2	Acceleration time 2
Active LEWT Setpoint	The current Leaving Evaporator Water Temperature Setpoint
Analog in loss	Analog input loss
Anig Cal Chksum	Analog input calculation check sum, math function
Autotune	Set point adjustments made automatically, not used by McQuay
AutoT MagRot	Autotune rotate, not used by McQuay
AutoT Rs Stat	Autotune static, not used by McQuay
CAN Bus Fit	Controlled area network bus fit
Command Speed	The speed command issued by the MicroTech controller to the VFD
DB	Dynamic breaking (not used on McQuay units)
Dec2	Deceleration 2, not used by McQuay
Decel Inhibit	Deceleration inhibited
Demand Limit	The maximum amp draw as established by the Demand Limit setpoint
Dig in Conflict	Digital input conflict, contradictory instructions
Drive OL	Drive overload
Esc/Prog	Exit a menu, cancel a change to a parameter, or toggle between program and process (user) display screens.
Flux Amps	Amount of current out of phase with the fundamental voltage component
Full Load	The vane open switch closes and the speed output = 100%. **Or** Load pulses exceed the full load setpoint timer (default 300 cumulative seconds) and the speed output = 100%. **Or** % RLA is above or equal to Max Amp Limit or Demand Limit. **Or** The evaporator pressure is below the low evap. pressure inhibit setpoint.
FVC	Flux vector control
HIM	Human interface module
IGBT	Insulated Gate Bi-polar Transistors
IntDBResOvrHeat	Dynamic breaking resistor temp. exceeded setpoint(not used on McQuay units)
Lift Temperature	Saturated condenser refrigerant temperature minus saturated evaporator temperature.
Lift Temperature Control Speed	The minimum speed to maintain lift and avoid surge. The controller continuously calculates the minimum operating speed in all modes, based on the lift temperature.
Low evap pressure inhibit setpoint	The low evaporator pressure that inhibits any further compressor loading
Manual Load Setpoint	MicroTech controller manual operation of the guide vanes for testing
Maximum Pulldown Rate	Maximum pulldown rate of chilled water in degrees per minute
MCB	Main control board
MCR	Motor control relay
Minimum Amp Setpoint	MicroTech controller minimum unloading setpoint
Minimum Rate Setpoint	Pulldown rate for MicroTech 200 controller
Minimum Speed	The minimum speed allowed, usually set at 70%
Mod	Module
Net	Network
Network Setpoint	Chilled water setpoint from an external source
NP Hz	
OIM	Operator interface module
PCB	Printed circuit board

Continued next page.

Precharge	Precharge capacitors
PWM	Pulse-width-modulated
Rapid Shutdown	If there is a fault, the MicroTech switches the state to VFD OFF. This includes changing the Unit Control Panel switch to OFF.
RLA	Rated Load Amps, the maximum motor amps
RMI	Remote meter interface, located in the VFD panel
Softloading	Extended ramp-up in capacity, set in the MicroTech controller
Speed	Speed signal to the compressor motor from the variable frequency drive (VFD) based on analog output (0 – 10 VDC) from the MicroTech controller.
Stage Delta	Multi compressor (or dual compressor unit) on/off cycling temperature delta-T
SVC	Sensorless vector control

Parameters

Throughout this manual, you will see references to parameter names and numbers that identify them for the drive. This manual uses the same format that will be shown on the keypad/display to refer to parameters:

P.nnn H.nnn R.nnn

Where: nnn is a number
P designates general parameters
H designates Volts/Hertz parameters
R designates optional RMI parameters

CAUTION

The original parameters values set by the McQuay startup technician must never be changed by anyone not specifically trained and experienced with these VFDs. Damage to the chiller or drive could occur.

Installation

Mounting Arrangements

Depending on size and type, VFDs may be factory-mounted with power and control wiring factory-installed or free-standing, requiring field mounting remote from the unit and field-wiring of power and control wiring. Because of dimension restrictions for shipping, some "factory-mounted" VFDs for some large chillers are shipped separate from the unit. Mounting supports are on the unit and preassembled cable kits are provided. Mounting and wiring on site are the customer's responsibility and can be subcontracted to McQuay Factory Service if desired.

Factory-Mounted (extra cost option): The VFD is mounted on the chiller unit with the back of the VFD against the motor terminal box and wired directly to the motor. This arrangement is only available on WSC/WDC 063, 079, or 087 units and with LF.

On models WSC/WDC 048/050, the VFD (LF only) is factory-mounted on the front of the chiller unit and connected to the motor with conduit and cable.

Free-standing (standard): Floor-mounted, separate from the chiller unit, and field wired to the compressor motor. This is available on all VFDs and is the only VFD arrangement available for WDC/WCC 100 and 126 dual compressor units.

Brackets and cable (extra cost option): VFDs (LF only) for WSC 100 to 126 single compressor units may be shipped separately from the chiller unit and furnished with mounting brackets and interconnecting cables for field mounting and connection by others. This option must be clearly specified when chillers are ordered since brackets are welded onto the evaporator during its construction.

Table 3, VFD Mounting Arrangements

Chiller Size	Air-Cooled/LiquiFlo			LiquiFlo 2.0
	Factory- Mounted	Free-Standing	Brackets & Cables	Free-Standing
WSC/WDC 050	X	X		X
WSC/WDC 063	X	X		X
WSC/WDC 079	X	X		X
WSC/WDC 087	X	X		X
WSC 100 - 126		X	X	X
WDC 100 – 126, WCC 100 - 126		X		X

Receiving

Since factory-mounted VFDs are mounted and wired at the factory, this section will only apply to free-standing units.

The unit should be inspected immediately after receipt for possible damage.

All McQuay centrifugal VFDs are shipped FOB factory and all claims for handling and shipping damage are the responsibility of the consignee.

Rigging

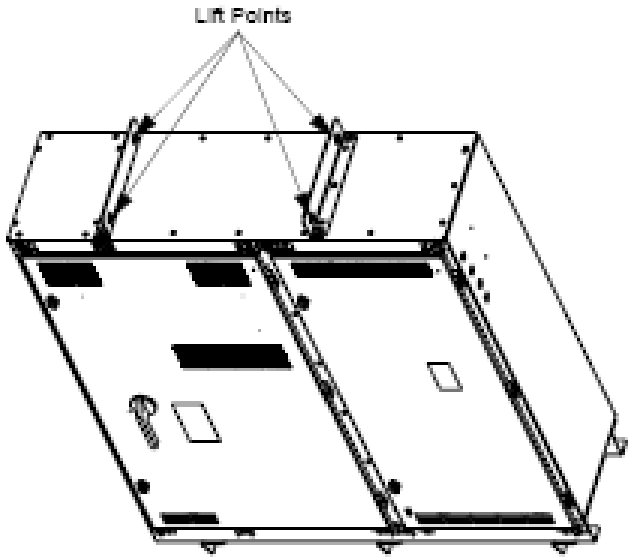
Extreme care must be used when rigging the equipment to prevent damage. See the certified dimension drawings included in the job submittal for the center of gravity of the unit. Consult the local McQuay sales office for assistance if the drawings are not available.

Air-Cooled, The unit can be lifted by fastening the rigging hooks to the two lifting eyes located on the top of the unit.

LiquiFlo; The unit can be lifted by fastening the rigging hooks to the four lifting eyes located on the top of the unit.

LiquiFlo 2.0:

Figure 2, LF 2.0, Lifting Points



Use the following procedure to lift and mount the LiquiFlo 2.0 drive:

Step 1. Using an overhead or portable hoist (minimum 2 ton rated capacity), attach a free-fall chain to the chain secured to the drive. Take up any vertical slack in the chain.

Step 2. Using the hoist, lift the drive from the horizontal shipping pallet.

Step 3. Position the drive.

Step 4. Machine or floor-mount the drive enclosure using 1/2-inch bolts, grade 5 or better, with compression washers.

Location and Mounting

Location

Consider the following guidelines: •

- Verify that NEMA 1 enclosure drives can be kept clean and dry.
- The area chosen should allow the space required for proper air flow. A minimum of 6-inch clearance is required wherever vents are located.
- Be sure that the NEMA 1 enclosure is installed away from oil, coolants, or other airborne contaminants.
- Do not install the drive above 1000 meters (3300 feet) without derating output power. For every 91.4 meters (300 feet) above 1000 meters (3300 feet), derate the output current 1%.
- Verify that the drive location meets the environmental conditions specified on page 5.
- Floor-mounted units should be attached to the floor with the C-channel rails provided.

Clearance

The VFDs must be mounted on a level concrete or steel base and must be located to provide adequate service. Local codes or the National Electric Code (NEC) can require more clearance in and around electrical components and must be checked.

Mounting

Make sure that the floor or structural support is adequate to support the weight of the unit shown on the dimension drawing.

Standard NEMA 1 and NEMA 12 VFDs must be installed indoors in an area that is not exposed to direct water spray. Do not install in areas where the ambient temperature falls below 32°F (0°C) or exceeds 104°F (40°C) enclosed, or 122°F (50°C) open unless this was noted at the time of order placement and special precautions were taken to protect against these abnormal temperatures.

Heatsink temperatures can run as high as 158°F (70°C) during normal operation. Do not mount the starter in contact with any material that cannot accept this heat. The VFD must be mounted with the heat sink fins oriented vertically in an area that will not experience excessive shock or vibration.

Grounding the Drive

Use the following steps to ground the drive:

Step 1. Open the door of the enclosure.

Step 2. Run a suitable equipment grounding conductor unbroken from the drive enclosure ground lug to earth ground. See figure 2.2. Tighten these grounding connections to the proper torque.

Step 3. Close the door of the enclosure.

Safety Precautions

Electrical codes require that all equipment (VFD, motor, operator station, etc.) be properly grounded. An incoming disconnect must be locked open before wiring or servicing the starter, motor, or other related equipment. The equipment must only be serviced by qualified personnel fully trained and familiar with the equipment.

The opening of the branch circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of electrical shock, current carrying parts and other components of the starter should be inspected and replaced if damaged.

Equipment is at line voltage when AC power is connected. Pressing the Stop push-button does not remove AC mains potential. All phases must be disconnected before it is safe to work on machinery or touch motor terminals and control equipment parts.

Cooling Requirements for VFDs

Air-cooled VFDs: all air-cooled have self-contained cooling systems and require no field work.

Water-cooleed, factory-mounted VFDs: VFD cooling water piping is factory-connected to the chiller's oil cooling system. See Figure 3. Cooling water piping is to the normal chiller oil-cooling system connections.

Freestanding VFDs: VFD cooling water piping must be field connected on freestanding units. See Figure 4. Cooling water is connected directly to models 047LA through 072LW. Models 090LW and 120LW, and all LF 2.0 units, are always freestanding and have a separate cooling module that must be field piped to the cooling water supply and also interconnected to the VFD. See page 15 for detailed installation instructions.

Figure 3, VFD 047 through 072, Cooling Water Piping for Factory-Mounted VFD

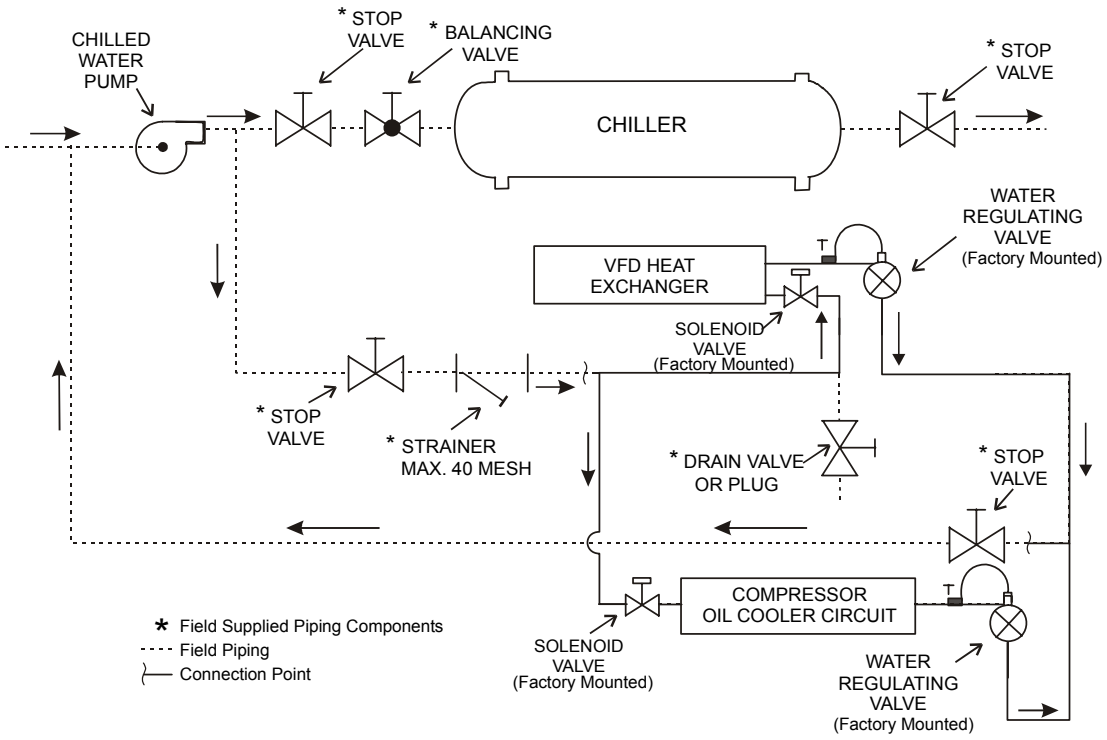
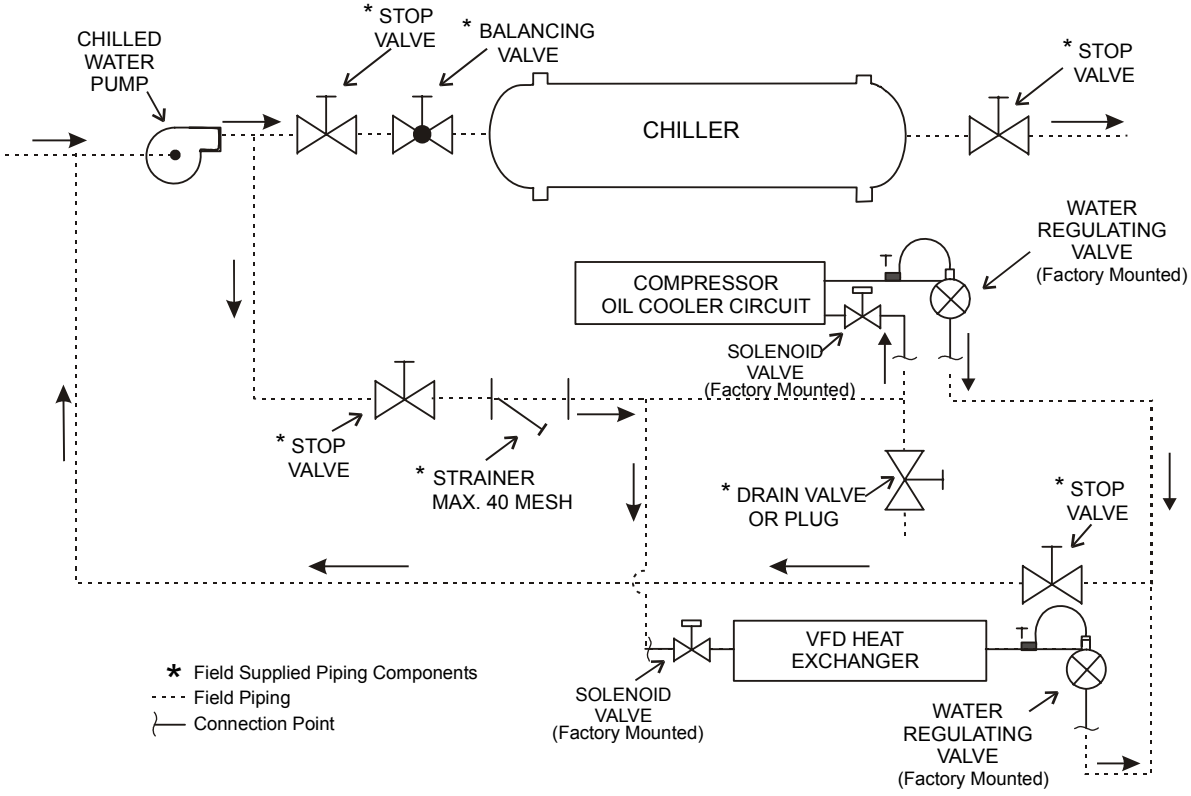


Figure 4, VFD 047 – 120 and all LF 2.0, Cooling Water Piping for Free-Standing VFD



NOTE: In some cases, the "VFD HEAT EXCHANGER" may be a separate-mounted cooling module that is, in turn, connected to the VFD.

Table 4, Cooling Requirements

McQuay Drive Model Number	Combined Comp. Oil and VFD Cooling Copper Tube Size	VFD Cooling Only, Copper Tube Size Type K or L	Coolant Method	Flow (gpm)	Max. Entering Coolant Temp. (° F)	Min. Entering Coolant Temp(° F)	Pressure Drop (feet)	Max. Pressure (Water Side) psi
Air-Cooled/LF								
VFD 009-028	N/A	N/A	Air	N.A.	104	40	NA	N/A
VFD 047	1.0	7/8 in.	Water (1)	2.0	90	40	10 (2)	300
VFD 060	1.0	7/8 in.	Water (1)	2.0	90	40	30 (2)	300
VFD 072	1.0	7/8 in.	Water (1)	2.5	90	40	30 (2)	300
VFD 090	1 1/4	1.0 in.	Water (1) (3)	7.0	90	40	30 (2)	300
VFD 120	1 1/4	1.0 in.	Water (1) (3)	7.0	90	40	30 (2)	300
LF 2.0								
VF 2037	N/A	3/4 NPT	Water (1) (3)	7.0	90	40	N.A.	180
VF 2055	N/A	3/4 NPT	Water (1) (3)	7.0	90	40	N.A.	180
VF 2080	N/A	3/4 NPT	Water (1) (3)	15.0	90	40	N.A.	180
VF 2110	N/A	3/4 NPT	Water (1) (3)	15.0	90	40	N.A.	180

Notes:

1. Cooling water must be from the closed, chilled water circuit with corrosion inhibitors for steel and copper, and must be piped across the chilled water pump.
2. The pressure drop is given for the maximum coolant temperature (maximum flow). The water-regulating valve will reduce the flow when the coolant temperature is below the maximum in the table. The pressure drop includes the drop across the solenoid valve, heat exchanger and water regulating valve.
3. Models VFD 090and 120 and all LF 2.0 models have a separate self-contained cooling loop with a recirculating water pump and heat exchanger, but have the same cooling source water piping as all water-cooled VFDs.

Table 5, Chiller Cooling Water Connection Sizes

Chiller Unit	Free-Standing VFD, LF and LF 2.0		Factory-Mounted VFD, LF Only
	To Oil Cooler	To VFD	Combined
WDC/WCC 100/126	1 1/2 in. FPT	¾ in. MPT	1 1/2 in. FPT
WSC/WDC 050	Not Required	Air-Cooled	Not Required
All Others	1 in. FPT	3/4 in MPT	1 in. FPT

Separate Cooling Module (LF VFD 090, 120 and all LF 2.0)

The cooling module for the LF models VDF 090 and 120 has a self-contained coolant temperature control system and no associated programming of the VDF is required. All cooling modules used with LF 2.0 VFD models are controlled by the VFD and require VFD programming as shown on page 19. This is done by McQuay at startup.

Closed loop cooling system operation

- A pump circulates a glycol/ water mixture (coolant) through the VFD heat sink, a coolant reservoir and a small plate heat exchanger. Heat is removed from the VFD heat sink and rejected to the plate heat exchanger.
- The pump and control valve are controlled by the VFD control system on LF 2.0 VFD models and self-contained on LF models.
- The plate heat exchanger is cooled by water from the chilled water system

Installation steps:

- Place cooling loop module in desired location.
- Attach coolant and chilled water piping. Seven to nine gpm of coolant will be circulated. A 40 mesh strainer is required at the drive inlet. Include service isolation valves in the coolant and chilled water inlet and outlet piping.

- Wire according to the supplied wiring diagrams.

The following is required from the customer's chilled water supply for the McQuay VFD cooling loop to perform properly.

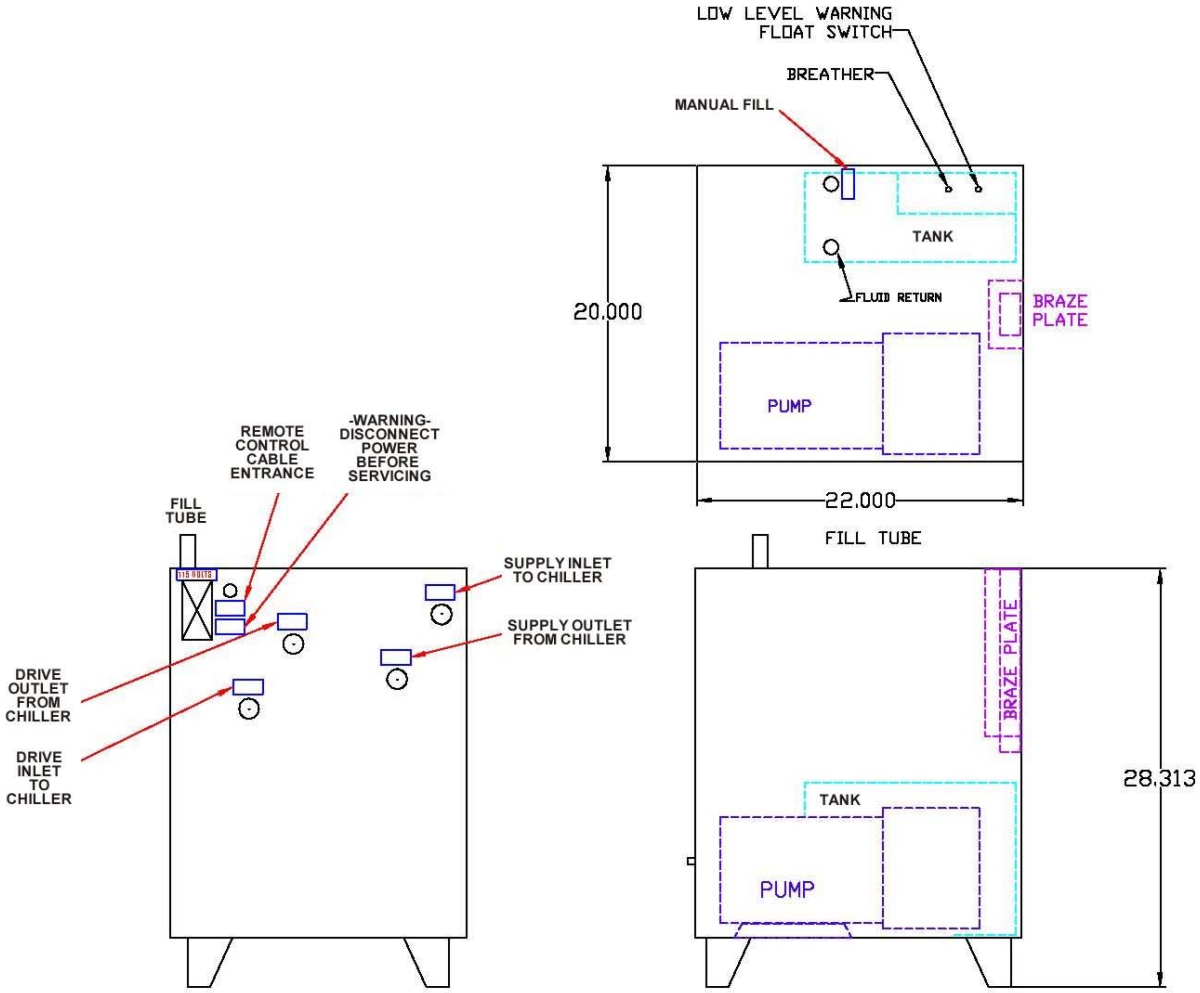
Water Quality:

Water must be compatible with components supplied in the cooling loop; brass, copper, stainless steel and neoprene rubber seals. Supply water circulates through a copper brazed stainless steel, plate type heat exchanger by way of a stainless steel and brass ball valve and associated stainless steel, brass and copper piping.

Water Source:

Clean and non-corrosive chilled water must be used as the coolant.

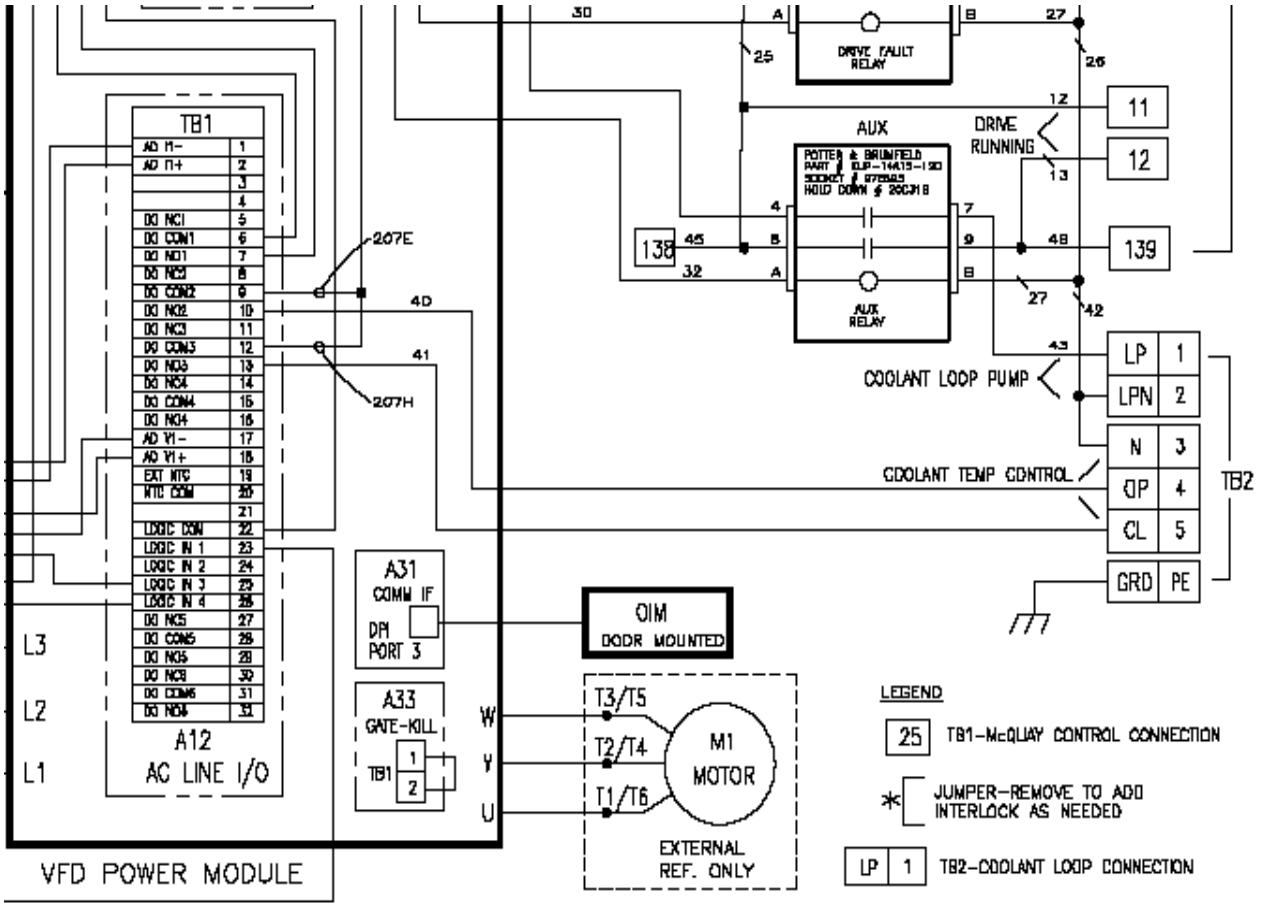
Figure 5, Cooling Module Dimensions



Weights

Shipping weight: 300 lbs (136 kg)
Dry weight: 250 lbs (114 kg)
Operating weight: 270 lbs. (123 kg)

Figure 6, LF 2.0 Remote Cooling Module Interconnecting Wiring



TB2 is the terminal board located in the remote module.

TB1 is a terminal board located in the VFD.

Field Wiring:

- TB1-10 (DO NO2) to TB2-4 (OP, Open)
- TB1-13 (DO NO3) to TB2-5 (CL, Close)
- Wire 42 (Aux Relay) to TB2-3 (Neutral)
- Wire 42 (Aux Relay) to TB2-2 (LPN, Loop Pump Neutral)
- Aux Relay Terminal 7 to TB2-1 (LP, Loop Pump)
- GRD (PE) to Ground

Maximum Static Pressure:
300 psi nominal limited by ball valve and piping pressure ratings.

Requirements for proper operation of the drive/ cooling module cooling loop.

Cooling Loop Liquid:
25% inhibited (corrosion protected) propylene glycol (DOWFROST or equivalent) concentration by volume with distilled water. Non-inhibited or silicate containing glycols may cause equipment damage.

Coolant Volume:
Approx. 1 gallon is required with side-by-side connection of cooling module to the drive cabinet. More coolant volume will be required if coolant loop is located up to 20 feet away from drive.

Coolant Maintenance:
The coolant liquid should be checked and refreshed as needed on a yearly basis. The pH should be maintained between 8.0 and 10.0. A 50% solution of sodium hydroxide or potassium hydroxide can be used to raise pH if falls below 8.0. Any time the coolant falls below a pH of 7.0 the loop should be flushed and coolant replaced. Any time the coolant appears other than water white it should be replaced.

Remote Mounted Cooling Loop:
The maximum distance the cooling loop can be installed away from the drive cabinet connections is 20 feet. Careful planning of remote mounting is required to minimize coolant flow restrictions introduced by piping connections.

Cooling Module Parameters Set in LF 2.0 VFD models
LF 2.0 drives control the operation of the cooling module. The parameters are set by McQuay at chiller commissioning.

How to Monitor Cooling Loop Operation

FX-05 Screen Navigation (see Figure 7)
After power-up the process temperature will be displayed.

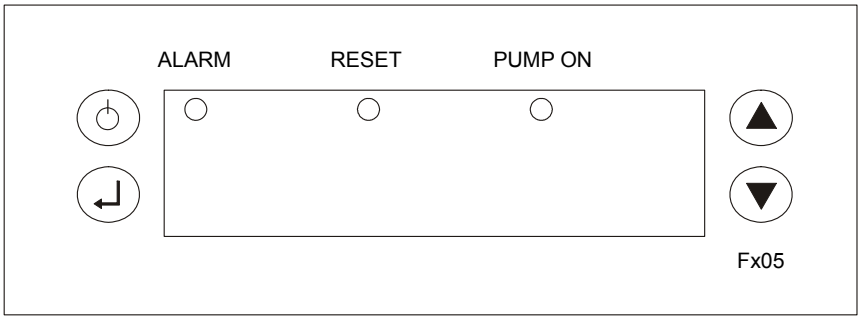
Alarms
When an alarm is present the alarm LED will blink fast and the error code will flash. The following is a list of the error code.

- E0: OK
- E1: Low Level Fault
- E2: Fluid Over-Temperature Fault
- E3: Fluid Under-Temperature Fault
- E4: Fluid Low Flow Fault

To acknowledge the alarms hold the ϕ key for 3 seconds. The alarm error code will be displayed and the reset led will light while the button is depressed. After the ϕ key is released the process temperature will be displayed.

To view the alarm summary hold both the ↵ ↓ keys for 3 seconds. To exit the alarm summary screen press the ϕ key or the screen will automatically time out after 10 seconds.

Figure 7, FX05 Display Panel



Operation

The FX controller controls to a fixed loop water setpoint.

Wiring, General

Unit-Mounted: Unit mounted VFDs have factory-wired control wiring plus power wiring from the VFD to the compressor motor terminals. The VFDs only require a power supply. Cable entrance is shown on the dimension drawings beginning on page 32 for LF and page **Error! Bookmark not defined.** for LF 2.0 models. An exception is on models LF models 090 and 120 and all LF 2.0 models that require some interconnection control wiring from the VFD to the remote cooling module as described in the section beginning on page 15.

Freestanding: Freestanding units require both field control and power wiring from the VFD to the chiller and. some interconnection control wiring on models 090 and 120.

Wiring Diagram: The control and power wiring diagram is located on page 25.

Power Wiring

Wiring, fuse and wire size must be in accordance with local codes and the National Electric Code (NEC).

CAUTION

Voltage unbalance not to exceed 2% with a resultant current unbalance of 6 to 10 times the voltage unbalance per NEMA MG-1, 1998 Standard. This is an important requirement to avoid excessive motor or drive heating.

WARNING

Qualified and licensed electricians must perform wiring. Shock hazard exists.

Power wiring to compressors must be in proper phase sequence. Motor rotation is set up for clockwise rotation facing the lead end with phase sequence of 1-2-3. Care must be taken that the proper phase sequence is carried through the VFD to the compressor. With the phase sequence of 1-2-3 and L1 connected to T1 and T6, L2 connected to T2 and T4, and L3 connected to T3 and T5, rotation is proper. See diagram in terminal box cover.

The McQuay start-up technician will check the phase sequence.

CAUTION

Connections to terminals must be made with copper lugs and copper wire.

Care must be taken when attaching leads to compressor terminals.

Note: Do not make final connections to motor terminals until wiring has been checked and approved by a McQuay technician.

Under no circumstances should a compressor be brought up to speed unless proper sequence and rotation have been established. Serious damage can result if the compressor starts in the wrong direction. Such damage is not covered by product warranty.

Compressor Motor Terminal Insulation

It is the installing contractor's responsibility to insulate the compressor motor terminals (as described below) when the unit is installed in a high humidity location that could cause condensate to form on the motor terminals. The terminals are cooled to 45°F to 50°F as a result of the motor cooling. The required material can be ordered and shipped in as a kit (775123601).

This is to be done after the McQuay start-up technician has checked for proper phase sequence and motor rotation.

Following this verification by the McQuay technician, the contractor should apply the following items.

Materials required:

1. Loctite® brand safety solvent (12 oz. package available as McQuay part number 350A263H72)
2. 3M™ Co. Scotchfil brand electrical insulation putty (available in a 60-inch roll as McQuay part number 350A263H81)
3. 3M Co. Scotchkote™ brand electrical coating (available in a 15 oz. can with brush as McQuay Part Number 350A263H16)
4. Vinyl plastic electrical tape

The above items are available at most electrical supply outlets.

Application procedure:

1. Disconnect and lock out the power source to the compressor motor.
2. Using the safety solvent, clean the motor terminals, motor barrel adjacent to the terminals, lead lugs, and electrical cables within the terminal 4OX to remove all dirt, grime, moisture and oil.
3. Wrap the terminal with Scotchfil putty, filling in all irregularities. The final result should be smooth and cylindrical.
4. Doing one terminal at a time, brush the Scotchkote coating on the motor barrel to a distance of up to '/2" around the terminal and on the wrapped terminal, the rubber insulation next to the terminal, and the lug and cable for approximately 10". Wrap additional Scotchfil insulation over the Scotchkote coating.
5. Tape the entire wrapped length with electrical tape to form a protective jacket.
6. Finally, brush on one more coat of Scotchkote coating to provide an extra moisture barrier.

General Wiring Practice

1. Never connect input AC power to the motor output terminals T1/U, T2/V or T3/W.
2. Power wiring to the motor must have the maximum possible separation from all other wiring. Do not run control wiring in the same conduit; this separation reduces the possibility of coupling electrical noise between circuits. Minimum spacing between metallic conduits containing different wiring groups should be three inches (76 mm).
3. Minimum spacing between different wiring groups should be six inches (152 mm).
4. Wire runs outside of an enclosure should be run in metallic conduit or have shielding/armor with equivalent attenuation.
5. Different wire groups should cross at 90 degrees whenever power and control wiring cross.
6. Different wire groups should be run in separate conduits.
7. Adhere to local electrical codes.
8. The National Electrical Code and Canadian Electrical Code requires that an approved circuit disconnecting device be installed in series with the incoming AC supply in a location readily accessible to personnel installing or servicing this equipment. If a disconnect switch is not supplied with the starter, one must be installed.
9. Supply lines and motor lines may enter the enclosure from the top, bottom or sides. Wire connections can be determined to best suit specific installations. Wire runs should be properly braced to handle both starting and fault currents. Size power cable per local electrical codes. Long lengths of cable to the motor of over 150 feet must be de-rated.

Terminal Sizes

Compressor Motor Terminals

Power wiring connections at the motor are “spark plug” type terminals with threaded copper bar, sized per the following table.

Table 6, Chiller Compressor Motor Terminal Sizes

Type/Size	Comp. Size	Terminal Size
Low Voltage to 275 A, to 575 V	CE 050	0.375-16 UNC2A, 0.94 in. long
Low Voltage to 750 A, to 575V	CE 063-126	0.635-11 UNC-2A, 1.88 in. long

VFD Terminals

For field wiring freestanding VFDs, the outgoing terminals and incoming power block terminals are determined by the VFD size listed in Table 8. For factory-mounted VFDs, the outgoing terminals are factory-connected to the compressor motor.

When wiring to a VFD with a disconnect switch or circuit breaker, the incoming lug size is determined by the device size as shown in Table 9.

Table 7, LiquiFlo 2.0, Terminal Size Range

VFD Size	Incoming Terminals	Outgoing Terminals
VF2037	Incoming connection is to the standard circuit breaker. See Table 9.	(3) 1.5 inch wide tab w/ 0.472 inch hole
VF2055		
VF2080		(3) 2.25 inch wide tab w/ 0.56 inch hole
VF2110		

Table 8, Air-Cooled/LiquiFlo, Outgoing, Incoming Power Block, Terminal Size Range

VFD Size		Incoming Power Block Terminals	Outgoing Terminals
VFD 009	SP600	#14 – 1/00	#14 – 1/00
VFD 012	SP600	#4 – 3/0	#4 – 3/0
VFD 015	SP600	#14 - 250	#14 - 250
VFD 017	SP600	#14 - 250	#14 - 250
VFD 023	SP600	#14 - 250	#14 - 250
VFD 024	PF700H	4/0 - 350	4/0 - 350
VFD 028	PF700H	4/0 - 350	4/0 - 350
VFD 047	LF	(2) #4 - 500	(2) #6 - 300
VFD 060	LF	(2) #4 - 500	(2) #4 - 350
VFD 072	LF	(2) #4 - 500	(2) #4 - 350
VFD 090	LF	(2) #4 - 500	2 in. x 1/4 in. bus (1) 9/16 in. hole
VFD 120	LF	(2) #4 - 500	2 in. x 1/4 in. bus (1) 9/16 in. hole

Table 9, Incoming Terminal Size Range, Disconnects & Circuit Breakers

Max RLA	Size	Incoming Terminal, Disconnect Switch or Circuit Breaker
74	100	(1) #6- 300
93	125	(1) #6- 300
148	200	(1) #6- 300
163	220	(1) 4/0 - 500
185	250	(2) 3/0 - 500
296	400	(2) 3/0 - 500
444	600	(3) 1/0 - 500
593	800	(4) 250 – 500
889	1200	(5) 300 – 600
1185	1600	(5) 300 - 600

NOTE: (X) is the number of terminals per phase.

Optional Line Reactor Installation, Air-Cooled/LF Only

Mounting Options

Optional line reactors can be mounted in the VFD enclosure on free-standing units and must be field-mounted and wired when the VFD is factory-mounted. When the reactor is installed in the VFD enclosure, a much larger enclosure is required and it is too large to mount on the chiller.

VFD Line Harmonics

VFDs have many benefits, but care must be taken when applying VFDs due to the effect of line harmonics on the building electric system. VFDs cause distortion of the AC line because they are nonlinear loads, that is, they don't draw sinusoidal current from the line. They draw their current from only the peaks of the AC line, thereby flattening the top of the voltage waveform. Some other nonlinear loads are electronic ballasts and uninterruptible power supplies.

Reflected harmonic levels are dependent on the source impedance and the KVA of the of the power system to which the drive is connected. Generally, if the connected power source has a capacity greater than twice the drive's rated amps (see Table 1 or Table 2 for rated amps), the installation will conform to IEEE Standard 519 with no additional attenuation. Presumably, the application on which this drive is applied has been checked for harmonic levels. If not, contact the local McQuay office.

The IEEE 519-1991 Standard

The Institute of Electrical and Electronics Engineers (IEEE) has developed a standard that defines acceptable limits of system current and voltage distortion. A simple form is available from McQuay that allows McQuay to determine compliance with IEEE 519-1991. Line harmonics and their associated distortion may be critical to AC drive users for three reasons:

1. Current harmonics can cause additional heating to transformers, conductors, and switchgear.
2. Voltage harmonics upset the smooth voltage sinusoidal waveform.
3. High-frequency components of voltage distortion can interfere with signals transmitted on the AC line for some control systems.

The harmonics of concern are the 5^{th}, 7^{th}, 11^{th}, and 13^{th}. Even harmonics, harmonics divisible by three, and high magnitude harmonics are usually not a problem.

Current Harmonics

An increase in reactive impedance in front of the VFD helps reduce the harmonic currents. Reactive impedance can be added in the following ways:

1. Mounting the drive far from the source transformer.
2. Adding line reactors.
3. Using an isolation transformer.

Voltage Harmonics

Voltage distortion is caused by the flow of harmonic currents through a source impedance. A reduction in source impedance to the point of common coupling (PCC) will result in a reduction in voltage harmonics. This may be done in the following ways:

1. Keep the point of common coupling (PCC) as far from the drives (close to the power source) as possible.
2. Increase the size (decrease the impedance) of the source transformer.

3. Increase the capacity of the busway or cables from the source to the PCC.
4. Make sure that added reactance is "downstream" (closer to the VFD than the source) from the PCC.

DANGER
High voltage is used in the operation of line/load reactors. Use Extreme caution to avoid contact with high voltage when operating, installing or repairing equipment containing line/load reactors.
INJURY OR DEATH MAY RESULT IF SAFETY PRECAUTIONS ARE NOT OBSERVED

DANGER
Even if the upstream disconnect/protection device is open, a drive or inverter down stream of the line/load reactor may feed back high voltage to the reactor. The inverter or drive safety instructions must be followed.
INJURY OR DEATH MAY RESULT IF THE SAFETY PRECAUTIONS ARE NOT OBSERVED

CAUTION
An upstream disconnect/protection device must be used as required by the National Electrical Code

CAUTION
The frame of line/load reactors must be grounded at least at one of the reactor's mounting holes.

This section is intended for use by personnel experienced in the operation and maintenance of electronic drives, inverters and similar types of power electronic equipment. Because of the high voltages required by the equipment connected to line reactors and the potential dangers presented by rotating machinery, it is essential that all personnel involved in the operation and maintenance of line/load reactors know and practice the necessary safety precautions for this type of equipment. Personnel should read and understand the instructions contained in this section before installing, operating or servicing line/load reactors and the drive to which the reactor is connected

AGENCY APPROVALS:

UL-508, File E180243 Component Recognized (1 amp – 2400 amps)

UL-508, File E180243 UL Listed Nema 1 units (1 amp – 2400 amps)

CSA C22.2, File LR29753-13 CSA Certified (1 amp – 1200 amps)

Class H, 200 C, File E66214, Type 180-36, UL Recognized Insulation System

CE

Ambient Temperature

Maximum ambient temperature is 45°C (113°F).

Figure 8, Line Reactor Dimensions, Models VFD 009 - 017

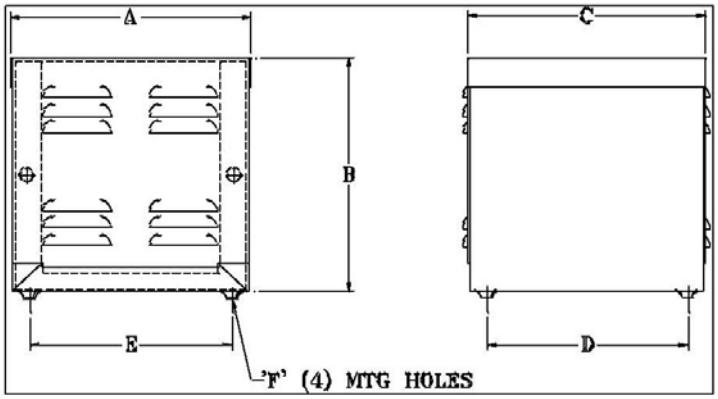


Figure 9, Line Reactor Dimensions, Models VFD 047 - 072

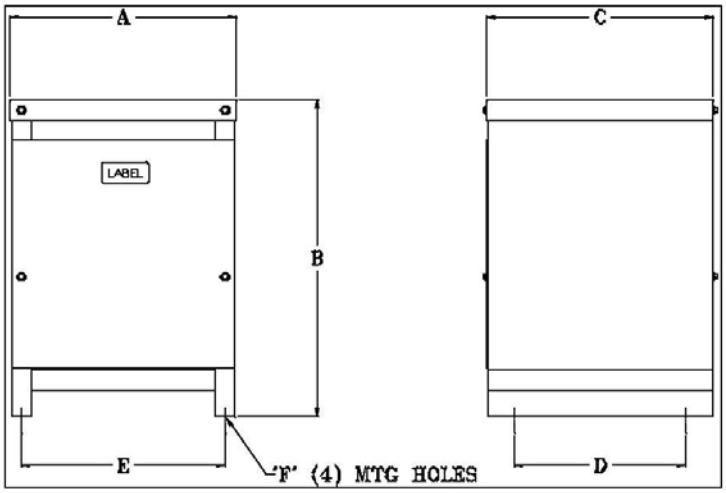


Table 10, Line Reactor Data

VFD Model	Width "A" in. (mm)	Depth "C" in. (mm)	Height "B" in. (mm)	Weight lbs (kg)	Wire Range	Torque In. lb.
009MA	13.2 (335)	13.2 (335)	13.2 (335)	86 (39)	6-0	6-4=45, 2-0=500
012MA–017MA	13.2 (335)	13.2 (335)	13.2 (335)	98 (44)	2-0000	2-1=150, 1/0-2/0=180, 3/0-4/0=250
023MA	17.0 (432)	17.0 (432)	24.0 (610)	151 (69)	00-500	00=180, 000-0000=250 250-350=325, 500=375
024-028	See Note 3					
047MW-060MW	17.0 (432)	17.0 (432)	24.0 (610)	225 (102)	See Note 2	
072MW	24 (610)	24 (610)	30 (762)	393 (178)	See Note 2	
090LW-120LW	See Note 3				See Note 4	

NOTES:

1. Models 012MA through 023MA have box lugs, one wire per lug.
2. Models 047MW through 072MW have copper tabs with (1) 0.656 hole.
3. Models 024LA/MA through 028LA/MA have reactor as standard and it is mounted in VFD. Wiring required to incoming reactor terminals.
4. Models 090LW through 120LW have (2) 0.656 holes, and are always shipped loose with reactors factory-mounted in VFD. Wiring required to incoming terminals.

Mounting

NEMA 1 enclosures designed for floor mounting must be mounted with the enclosure base horizontal for proper ventilation. Wall mounting a floor mounted enclosure with the base against the wall will cause the reactor to over heat resulting in equipment damage.

Allow a minimum side, front, and back clearances of 12 inches (305 mm) and vertical clearances of 18 inches (457 mm) for proper heat dissipation and access. Do not locate the enclosure next to resistors or any other component with operating surface temperatures above 260°F (125°C).

Allow a minimum side, front, and back clearances of 12 inches (305 mm) and vertical clearances of 18 inches (457 mm) for proper heat dissipation and access. Do not locate the enclosure next to resistors or any other component with operating surface temperatures above 260°F (125°C).

Select a well ventilated, dust-free area away from direct sunlight, rain or moisture, where the ambient temperature does not exceed 45°C (113°F).

Do not install in or near a corrosive environment.

Avoid locations where the reactor will be subjected to excessive vibrations.

Where desirable, enclosures may be mounted on vibration isolating pads to reduce audible noise. Standard vibration control pads made from neoprene or natural rubber and selected for the weight of the enclosed reactor are effective.

Reactor Power Wiring

WARNING
Input and output power wiring to the reactor must be performed by authorized personnel in accordance with the NEC and all local electrical codes and regulations.

Verify that the power source to which the reactor is to be connected is in agreement with the nameplate data on the reactor. A fused disconnect switch or circuit breaker should be installed between the reactor and its source of power in accordance with the requirements of the NEC and all local electrical codes and regulations. Refer to the drive, inverter, or other electrical equipment user manual for selection of the correct fuse rating and class.

The reactor is suitable for use on a circuit capable of delivering not more than 65,000 rms symmetrical amperes at 480 volts when protected by Bussman type JJS, KTK, KTK-R, PP or T class fuses.

Reactors are designed for use with copper conductors with a minimum temperature rating of 75°C. Table 10 lists the wire range for the power input and output connections by VFD model.

Refer to

Figure 10 for a typical electrical diagram of a reactor in its proper location, upstream of a VFD.

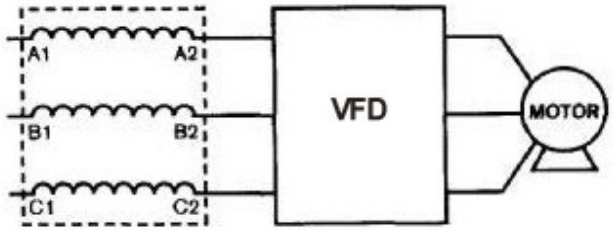
Where desirable, a flexible conduit connection to the reactor enclosure should be made to reduce audible noise.

Failure to connect reactors supplied as a component part of a drive system or other power electronic system according to the system interconnection diagram supplied by the System Engineer will result in equipment damage, injury, or death.

WARNING

If a line reactor or a line reactor and a load reactor are used with a drive equipped with a bypass circuit, the reactors must be removed from the motor circuit in the bypass mode. Damage to the motor and other equipment will result if this warning is not observed.

Figure 10, Line Reactor Wiring



Grounding

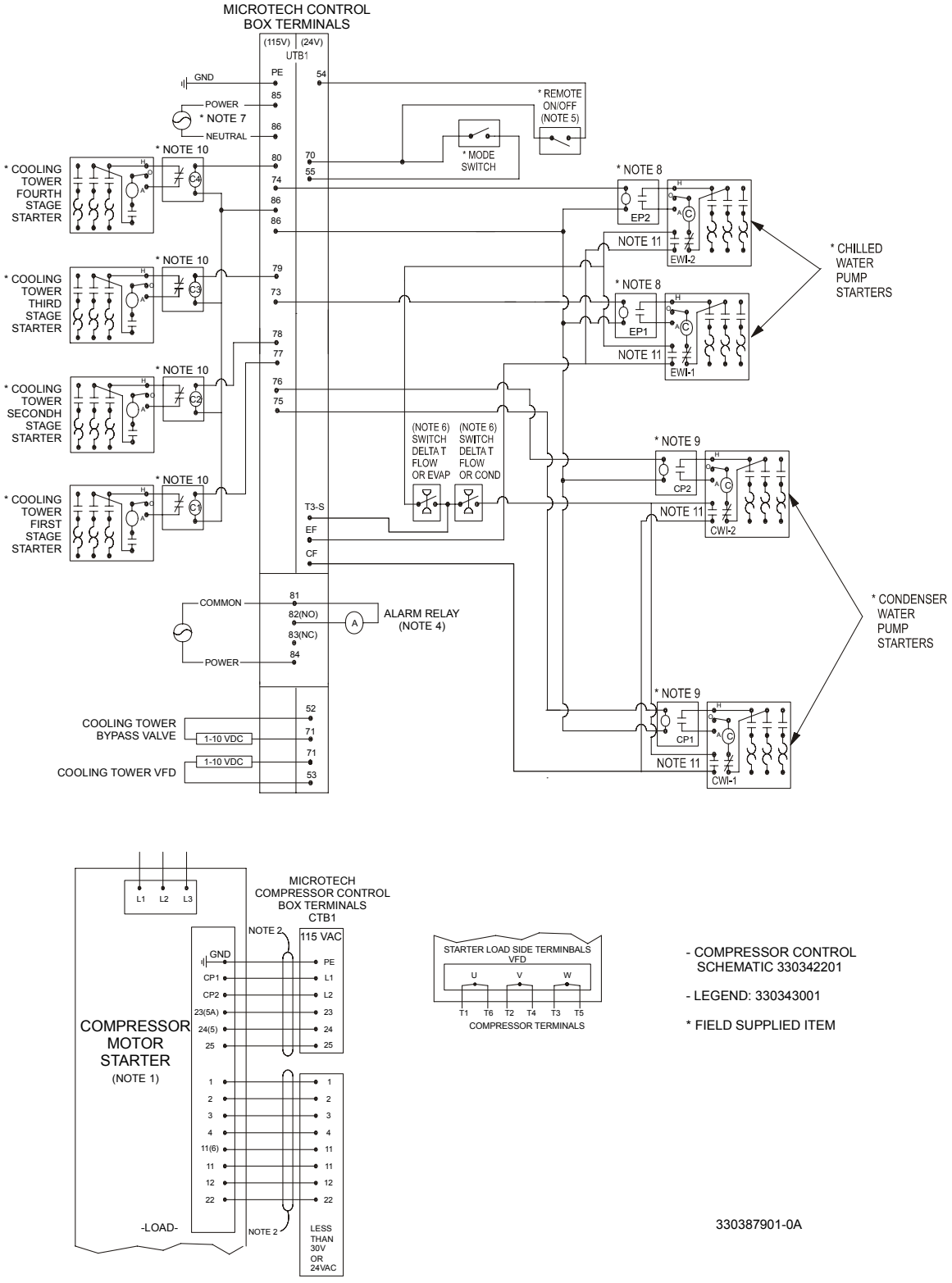
A stud is provided in the reactor enclosure for grounding the enclosure. The enclosure must be grounded.

WARNING

The frame of line/load reactors must be grounded at the designated grounding terminal or one of the reactor mounting holes if no designated grounding terminal is provided. The enclosure of reactors supplied in enclosures must be grounded. INJURY OR DEATH MAY RESULT IF SAFETY PRECAUTIONS ARE NOT OBSERVED.

VFD/Chiller Interconnection Wiring Diagram

Figure 11, Control and Power Wiring Diagram



See notes on following page.

NOTES for Wiring Diagram

1. Compressor motor VFDs are either factory-mounted and wired, or shipped separate for field-mounting and wiring. VFDs must be provided by McQuay. All line and load side power conductors must be copper.

2. If VFDs are freestanding, then field control wiring between the starter and the control panel is required. Minimum wire size for 115 Vac is 12 GA for a maximum length of 50 feet. If greater than 50 feet, refer to McQuay for recommended wire size minimum. Wire size for 24 Vac is 18 GA. All wiring to be installed as NEC Class 1 wiring system and must be made with copper wire and copper lugs only. All 24 Vac wiring must be run in separate conduit from 115 Vac wiring.

3. Main power wiring between VFD and motor terminals is factory-installed when chillers are supplied with unit-mounted VFDs.

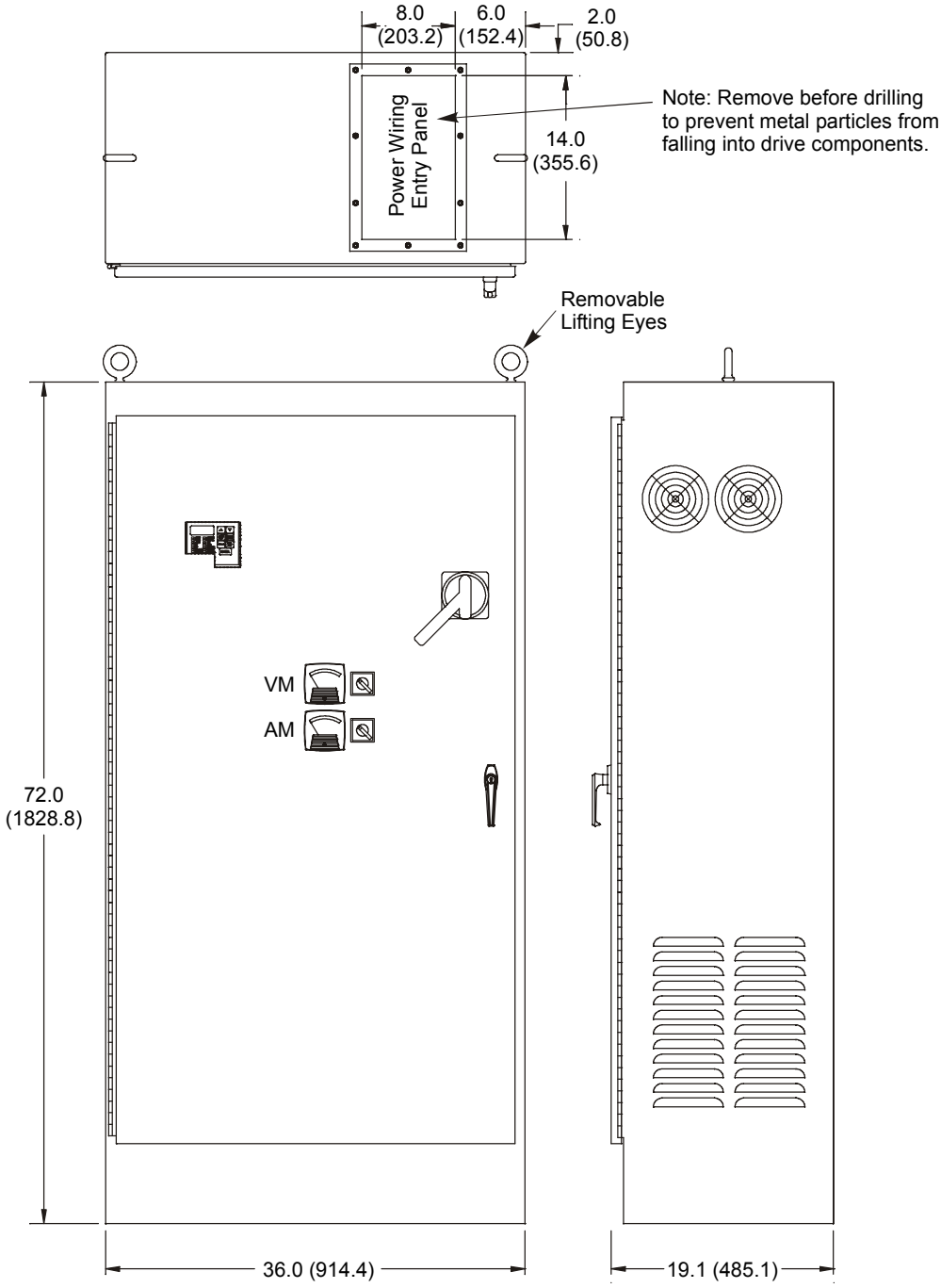
4. Six conductors are used between the VFD and the motor as shown in the wiring diagram. Wiring of free-standing VFDs must be in accordance with the NEC and connection to the compressor motor terminals must be made with copper wire and copper lugs only.

5. LF models VFD 090 and 120 and all LF 2.0 models require field wiring between the VFD and the field mounted cooling module per instruction beginning on page 15.

VFD Dimensions

Air-Cooled

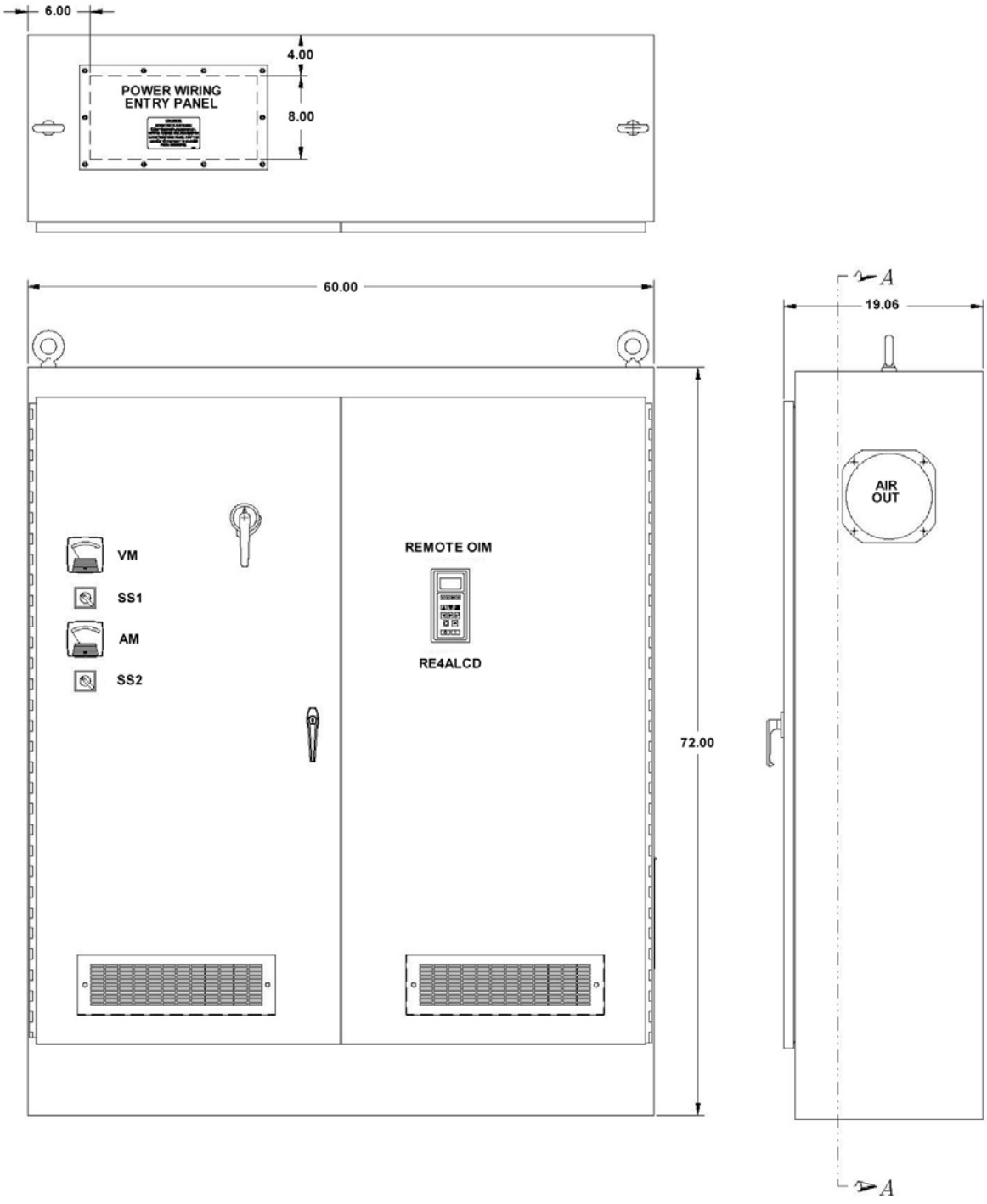
Figure 12, VFD 009LA/023LA, Air-Cooled, Free-Standing



Unit Weights

Model	VFD 009	VFD 012	VFD 015	VFD 017	VFD 023
Operating Weight, lb (kg)	725 (329)	725 (329)	796 (361)	796 (361)	796 (361)
Shipping Weight, lb. (kg)	795 (361)	795 (361)	866 (393)	866 (393)	866 (393)

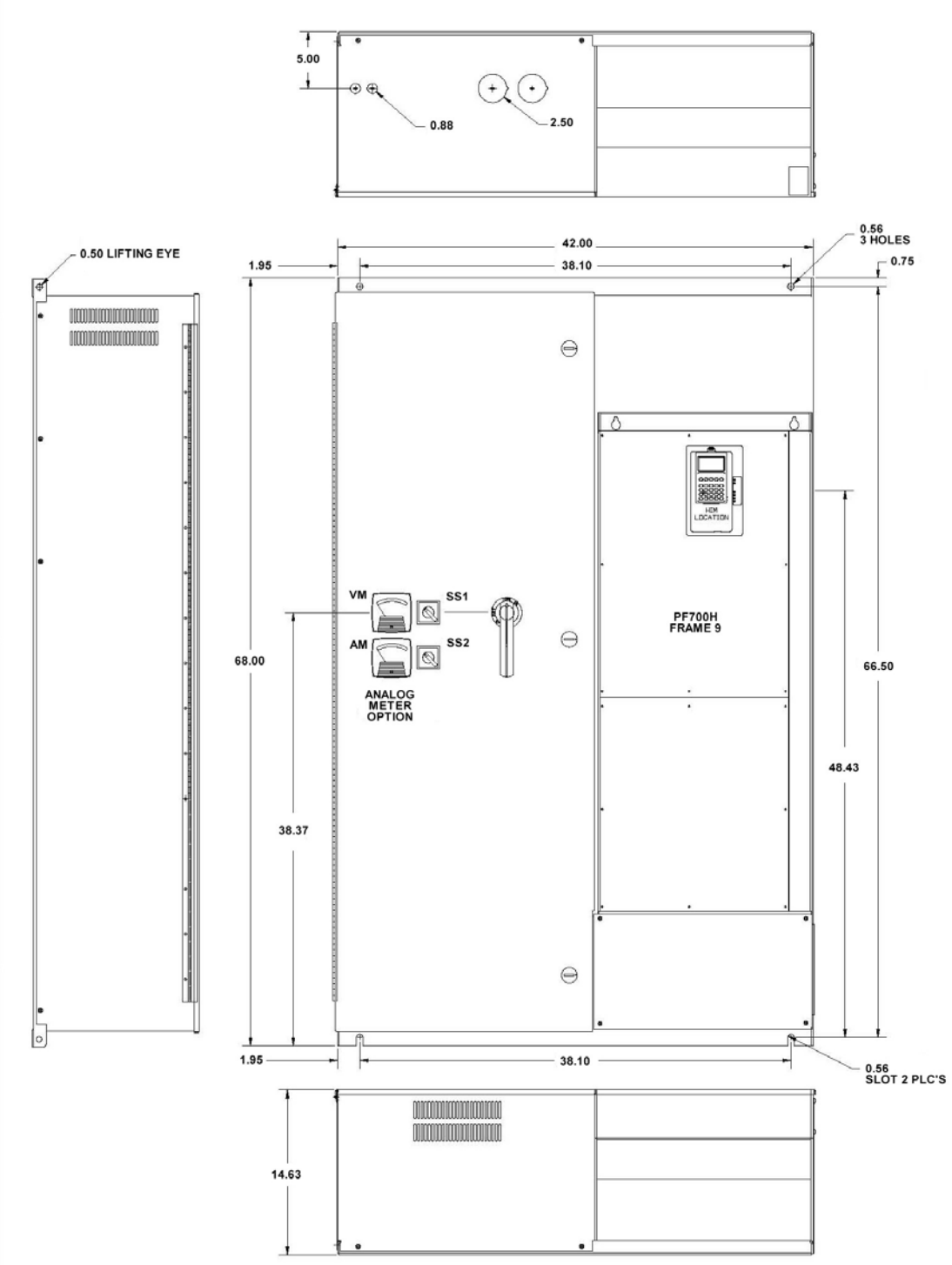
Figure 13, VFD 024LA/028LA, Air-Cooled, Free-Standing



Unit Weights

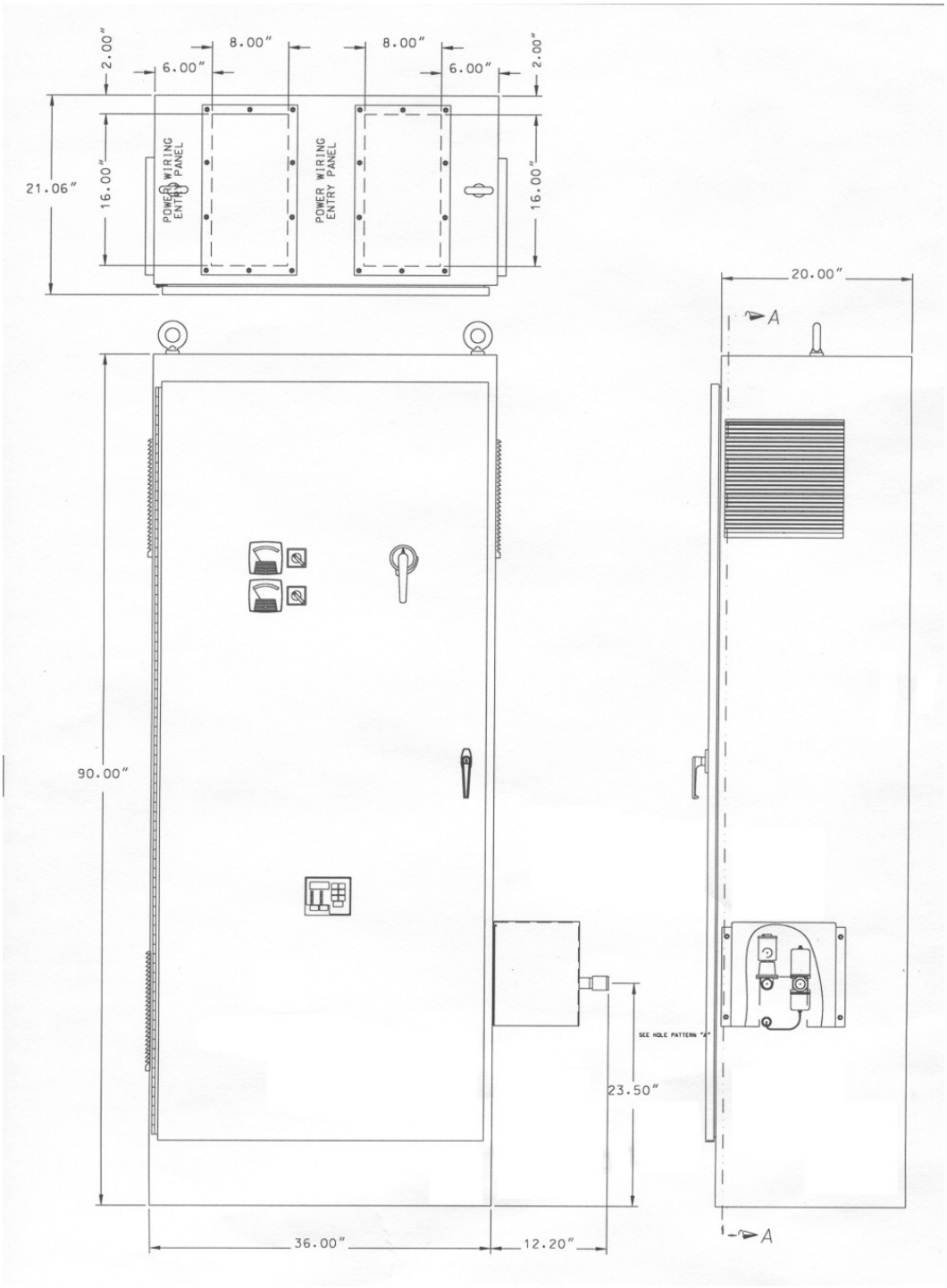
Model	VFD 024LA	VFD 028LA
Operating Weight, lb. (kg)	1206 (548)	1206 (548)
Shipping Weight, lb (kg)	1326 (602)	1326 (602)

Figure 14, VFD 009MA/028MA (Air-Cooled), Unit Mounted



NOTE: Incoming cable entrance is top-left. Outgoing wiring is factory-installed.

Figure 15, VFD 047LW, Water-Cooled, Free-Standing

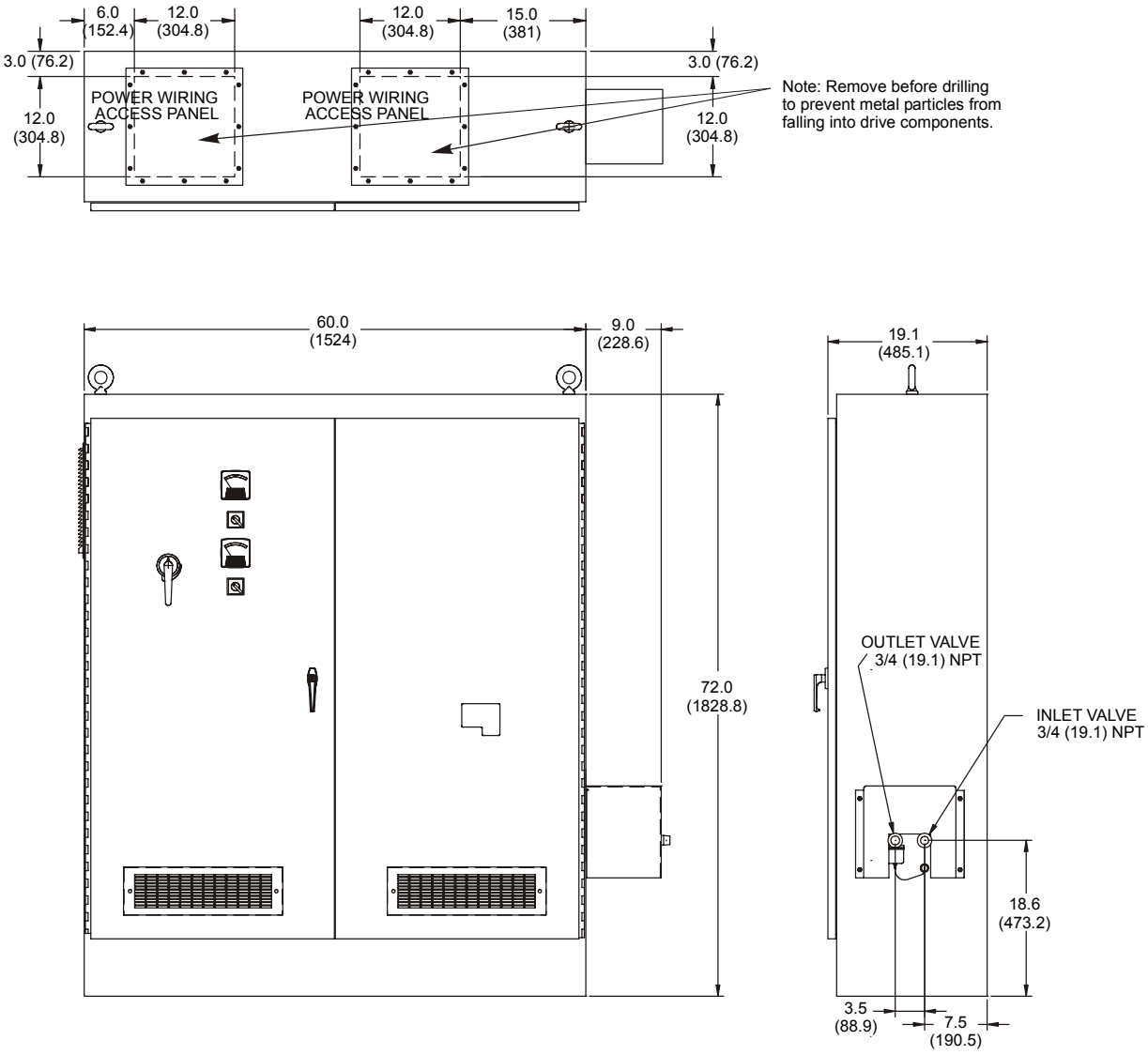


NOTES: Power entry for unit-mounted VFD is on top, left hand.

Unit Weights

Model	VFD 047LW
Operating Weight, lb. (kg)	982 (446)
Shipping Weight, lb (kg)	1070 (486)

Figure 16, VFD 060LW/072LW, Water-Cooled, Free-Standing

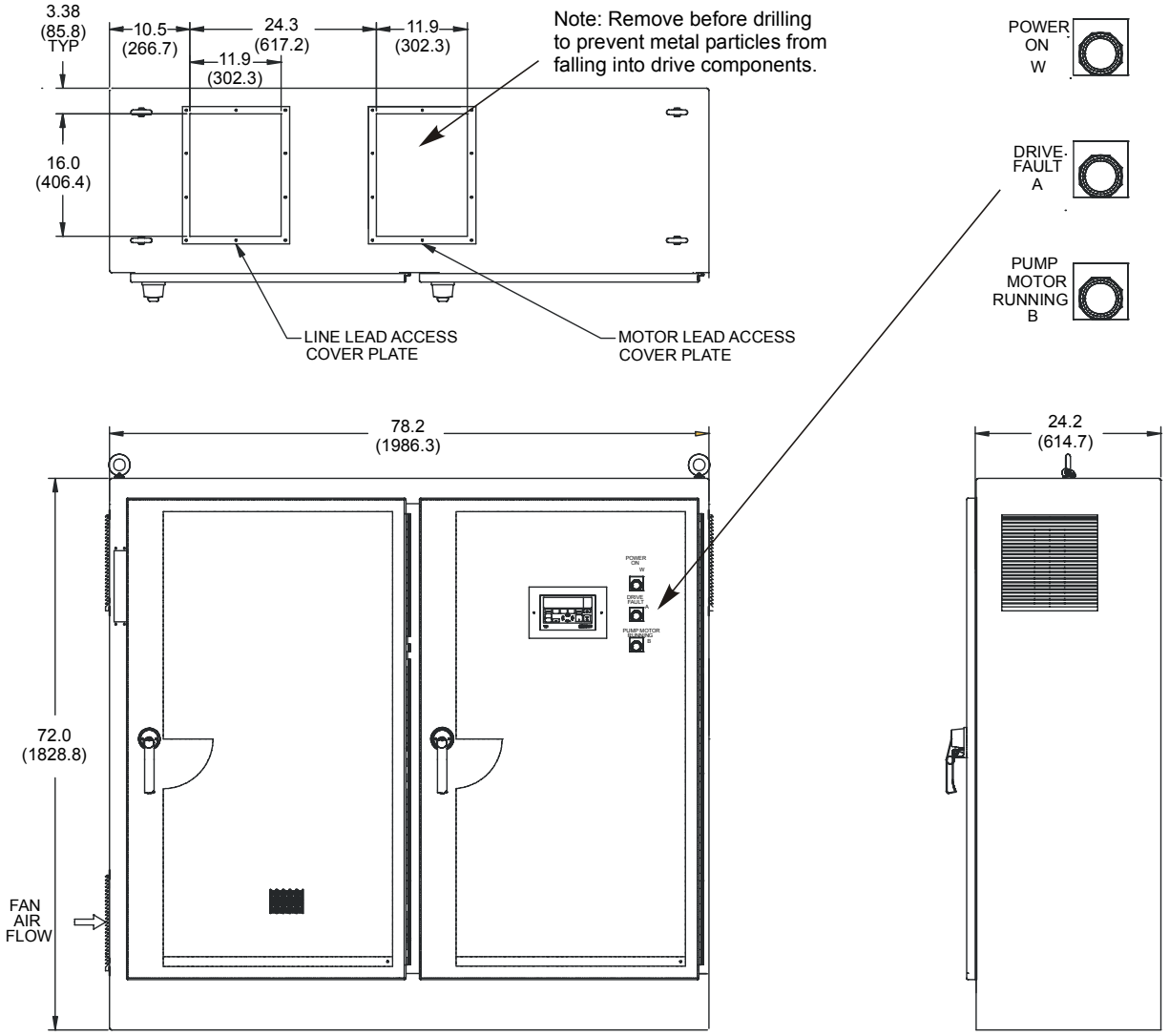


NOTES: Power entry for unit-mounted VFD is on top, left hand.

Unit Weights

Model	VFD 060	VFD 072
Weight lb. (kg)	1272 (577)	1272 (577)

Figure 17, VFD 090LW/120LW, Water-Cooled, Free-Standing Only



NOTE: The shipped loose, field installed, closed loop cooling module is shown installed adjacent to the VFD. It can also be install separated from it. See page 15 for installation instructions.

Unit Weights

Model	VFD 090	VFD 120
Weight lb. (kg)	1800 (817)	1800 (817)

Figure 18, VFD 047MW-072MW, Water-Cooled, Unit Mounted

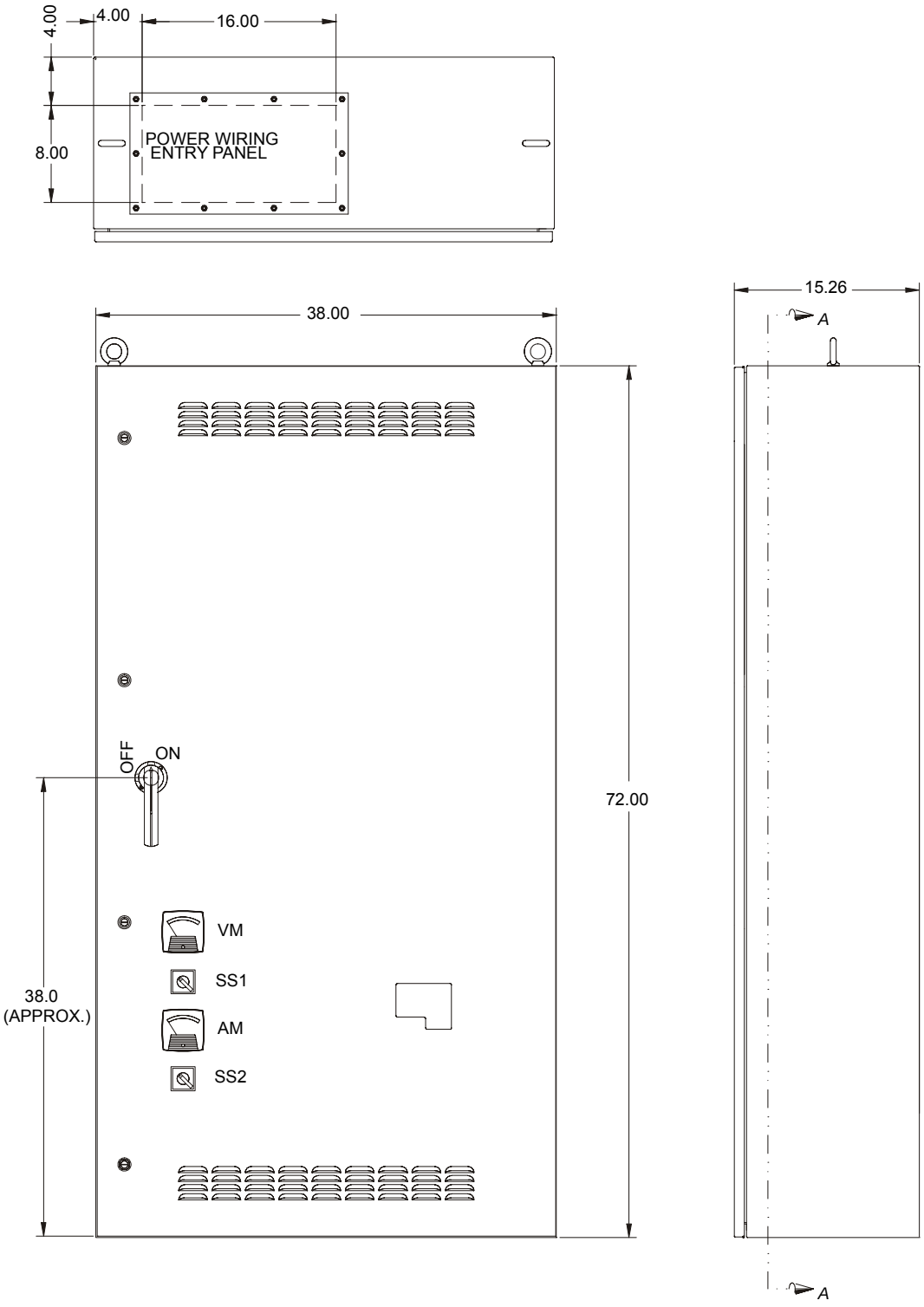
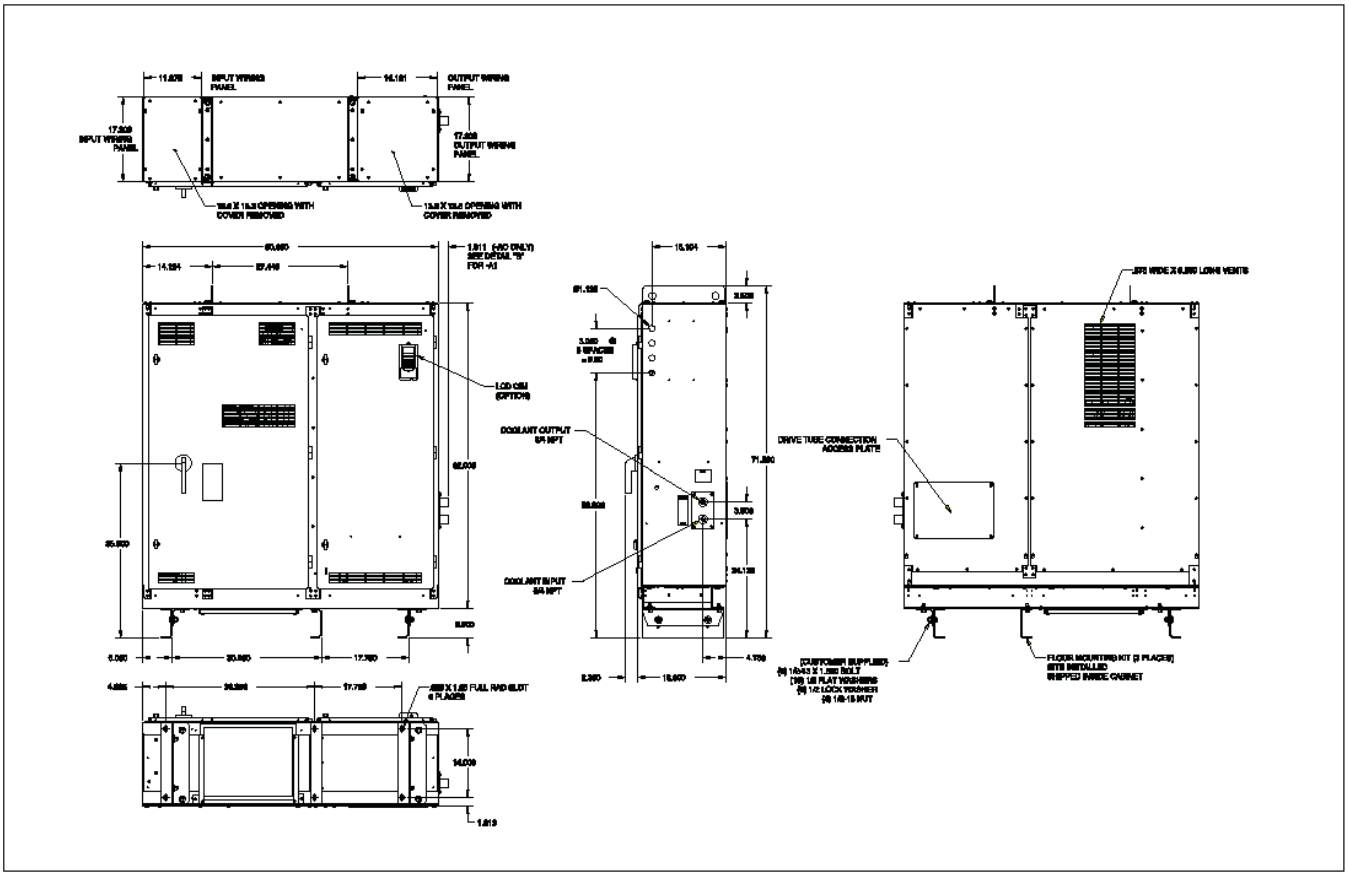


Figure 19, VF 2037-2055;Free Standing

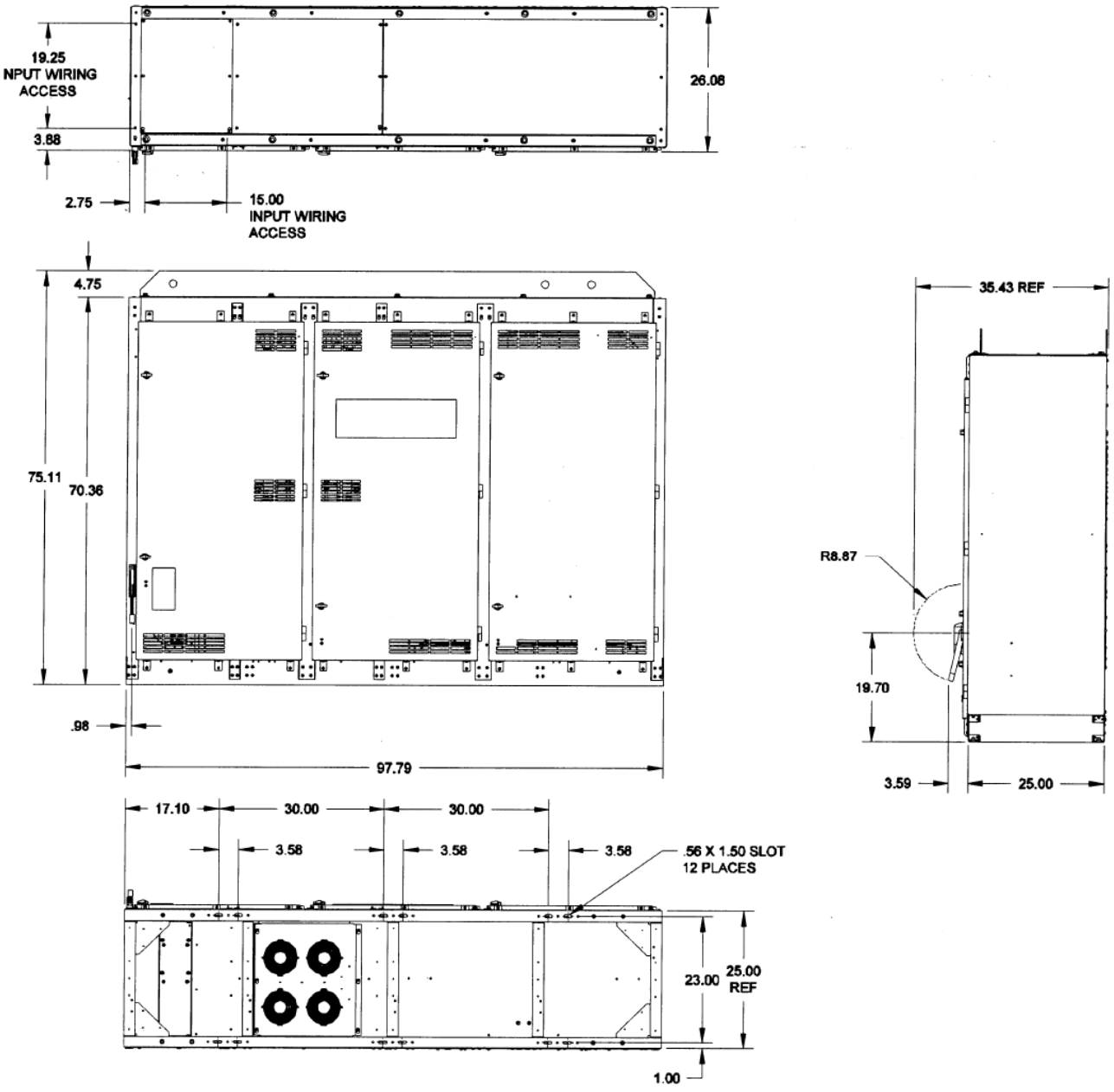


NOTE: Closed loop cooling module is also required.

Unit Shipping Weights

Model	VF 2037	VF 2055
Weight lb. (kg)	1600 (726)	1600 (726)

Figure 20, VF 2080-2110, Free Standing

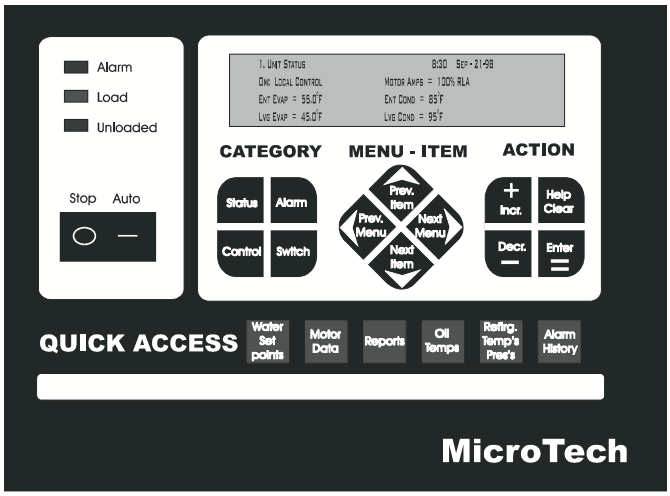


NOTE: Closed loop cooling module is also required.

Unit Shipping Weights

Model	VF 2080	VF 2110
Weight lb. (kg)	2000 (908)	2000 (908)

Figure 21, MicroTech 200 Control Panel



The MicroTech 200™ unit controller has control wiring to the variable frequency drive instead of to a motor starter. The MicroTech controller provides the speed setpoint signal to a hardwired input on the VFD. The output on the MicroTech AOX (auxiliary output) board is configured (using jumpers) to provide a 0-10 VDC signal to a hard wired analog input on the VFD.

There is no feedback signal required from the variable frequency drive to the MicroTech to indicate the speed of the motor. The actual percent motor speed is within 1% of the analog output signal from the MicroTech controller.

Digital Input, DI 10, is wired to a switch on the compressor that indicates when the vanes are 100% open (VO switch). If the switch is open, the status of the vanes is Not Open. If the switch is closed, the status of the vanes is Open.

VFD Chiller Control States

There are seven VFD chiller control states viewable as shown below. They are based on the unit status. See Table 12 on page 45 for relationships.

MicroTech: Menu 1, Screen 2, States

MicroTech 200
VFD Off
VFD Start
VFD Running: Adjust Speed & Open Vanes
VFD Running: Hold Minimum Speed & Adjust Vanes
VFD Routine Shutdown
VFD Locked Speed
VFD Override Capacity Control

VFD Off: The VFD is turned off, the speed output is 0%, and the vanes are closed.

VFD Start: The VFD is turned on, the speed output is minimum speed, and the vanes are modulated to maintain the leaving evaporator setpoint. (VFD running, hold minimum speed, and adjust vanes mode.)

VFD Running Adjust Speed & Open Vanes: The VFD remains on, the speed output is modulated to maintain the leaving evaporator setpoint, and the vanes are pulsed to the open position. This mode drives the vanes open and uses the speed to control capacity based on the evaporator leaving water setpoint.

VFD Running Hold Minimum Speed & Adjust Vanes: The VFD remains on, the speed output is held at Minimum Speed, and the vanes are modulated to maintain the evaporator leaving water setpoint. This mode occurs when the load (tons) can be satisfied with the vanes not fully open while at minimum speed. Decreasing speed can no longer reduce capacity, so the vanes maintain temperature control. When the load increases, the vanes will pulse open until the vane open switch shows that the vanes are full open. At this point, the MicroTech controller changes the mode to VFD Running: Adjust Speed and Open Vanes.

VFD Routine Shutdown: The VFD remains on, the speed output remains the same, dependent on the prior state, and the vanes are driven closed.

VFD Locked Speed: The MicroTech has a VFD LOCKED Speed Setpoint that can be selected either "ON" or "OFF" from the MicroTech controller keypad. When the VFD Locked Speed mode is set to ON, the VFD speed will be locked at the locked speed setpoint (keypad adjustable). The purpose of this mode is to allow proper setup (calibration, testing, etc.) of the chiller at a constant speed with constant conditions.

NOTE: Do not set the drive minimum speed above the factory setpoint to limit reduced speed. A control incompatibility will result between the MicroTech controller and the drive.

Override Capacity Control: Any capacity override (see Capacity Overrides on page 48) that forces the VFD out of normal speed control. To return to normal speed control, the capacity override condition is corrected.

First level capacity overrides hold speed and vane position while waiting for the condition to correct.

If the override condition becomes critical (second level capacity override), speed and vane position will be modulated in an attempt to correct the critical condition.

Control Sequence, MicroTech 200

VFD Off: The VFD is turned off, the speed output is 0%, and the vanes are closed. If the chiller is turned on and if there is a load, the chiller will go through its start sequence; and when the unit status reaches Motor Control Relay (MCR) Started, the VFD status (MicroTech II controller Menu 1 Screen 2) will switch to "VFD Start".

VFD Start: The VFD is turned on, the speed output is minimum speed, and the vanes are modulated to maintain the chilled water setpoint (Active Setpoint on keypad/display). At the same time, the minimum speed will continually be re-calculated based on the lift temperature.

In the start mode, capacity control is "Hold Minimum Speed & Adjust Vanes" to satisfy the Active Setpoint (leaving chilled water temperature). When the vanes have been pulsed to the full open position, the Vane Open (V.O) switch closes, the VFD mode changes to "VFD Running" adjust speed, open vanes".

VFD Running Adjust Speed & Open Vanes: The VFD remains on, the speed output is modulated to maintain the Active Setpoint, and the vanes are driven to the open position. As the load decreases; if the Speed equals the lift temperature control speed, and the Leaving Evaporator Water Temperature (LEWT) is less than the active setpoint minus one-half the control band, the mode switches to "VFD Running: Hold Minimum Speed & Adjust Vanes". Otherwise, the controller stays in this mode.

If any capacity override exists, the VFD mode changes to the "Override Capacity Control" mode (see Capacity Overrides on page 48).

VFD Running Hold Minimum Speed & Adjust Vanes: The VFD remains on, the command speed is held at Minimum Speed, and the vanes are modulated to maintain the Active Setpoint. As the load increases; if the vane open switch closes, and the LEWT is greater than the active setpoint plus ½ the control band, the mode switches to "VFD Running Adjust Speed & Open Vanes". Otherwise, the controller stays in this mode with the speed at Minimum Speed and the vanes being controlled to satisfy the Active Setpoint. If any capacity override exists, the VFD mode changes to the "Override Capacity Control" mode.

VFD Routine Shutdown: The VFD remains on, the speed output remains constant, and the vanes are driven closed. This state is used during a routine shutdown of the chiller. If there is a rapid shutdown cause by a fault alarm, the state switches to "VFD Off".

Rapid Shutdown: If there is a fault alarm, the mode immediately switches to VFD OFF. "Rapid Shutdown" also occurs by changing the front panel "Stop/Auto" switch on the MicroTech to "Stop".

WDC/WCC, Dual Compressor VFD Operation

The MicroTech 200 controller has the capability to control a dual compressor VFD chiller or two stand-alone VFD chillers with interconnecting network communications, including all lead/lag load balance functions.

The lead compressor starts and runs the same as a single VFD compressor, controlling speed and vane position based on Leaving Evaporator Water Temperature (LEWT). When the capacity of the lead compressor reaches an equivalent user defined speed, LEWT offset, and pull down rate, it indicates to the master control panel that it is time to enable the lag (second) compressor to satisfy additional cooling requirements.

When the master control panel sees the enable lag indication, it checks the LEWT and if it is greater than the active setpoint plus the lag Start UP (S/U) Delta T, it will start the lag delay timer (keypad adjustable). At this time, the MicroTech control will record the evaporator chilled water Delta T for reference to determine lag compressor shutdown.

NOTE: Operation assumes constant chilled water flow for dual compressor, VFD units.

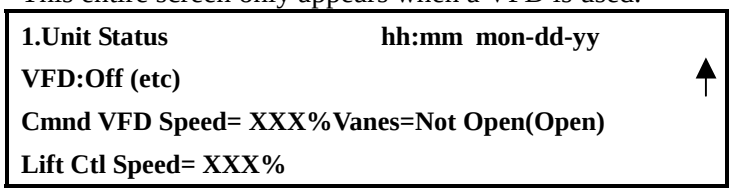
The MicroTech is constantly looking at the recorded startup evaporator Delta T, the user adjustable offset from the delta T, and the active setpoint. As the load decreases, and the evaporator Delta T drops below the recorded Startup Delta T minus the user adjustable offset, and the LEWT is below the active setpoint minus the control band plus user defined offset, the user adjustable lag compressor shutdown timer (same time as the lag start timer) is activated. When the timer times out, and the above conditions still exist, the lag compressor will be shut down.

MicroTech 200 Controller VFD Menu Screens

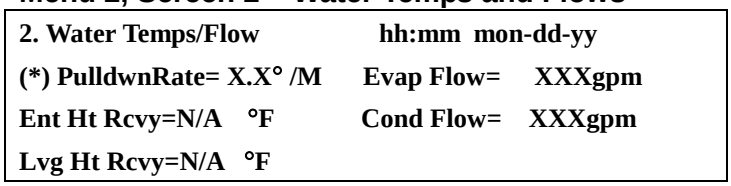
The MicroTech controller screens are modified from standard when VFD software is loaded into the microprocessor in the factory. VFDs require special software as described in this section. The screens are grouped by "menus" that are further broken down to screen numbers. Fields noted with an (*) are only active when a VFD is used. Arrows indicate that addition related screens are located above or below.

Menu 1, Screen 2– Unit Status

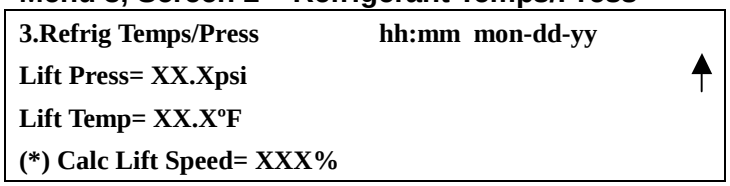
This entire screen only appears when a VFD is used.



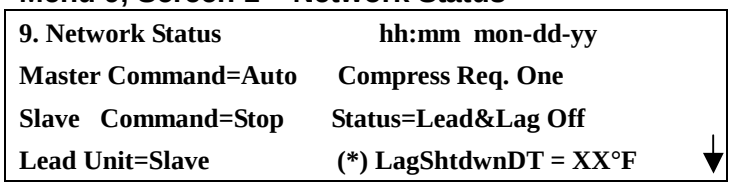
Menu 2, Screen 2 – Water Temps and Flows



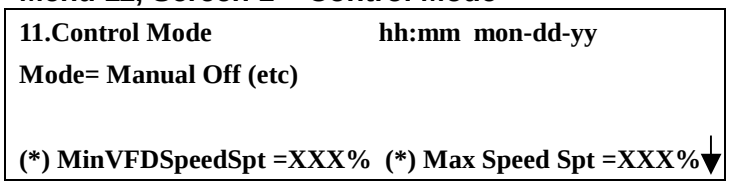
Menu 3, Screen 2 – Refrigerant Temps/Press



Menu 9, Screen 1 – Network Status

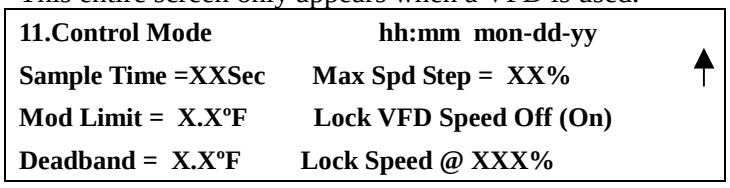

9. Network Status hh:mm mon-dd-yy
Master Command=Auto Compress Req. One
Slave Command=Stop Status=Lead&Lag Off
Lead Unit=Slave (*) LagShtdwnDT = XX°F

Menu 11, Screen 1 – Control Mode

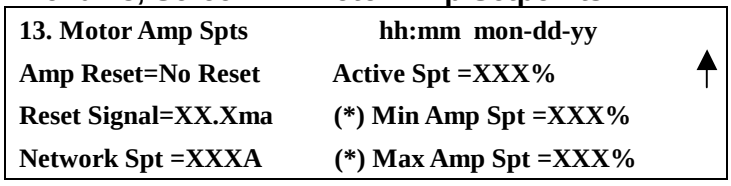


Menu 11, Screen 2 – Control Mode Setpoints

This entire screen only appears when a VFD is used.


11.Control Mode hh:mm mon-dd-yy
Sample Time =XXSec Max Spd Step = XX%
Mod Limit = X.XºF Lock VFD Speed Off (On)
Deadband = X.XºF Lock Speed @ XXX%

Menu 13, Screen 1 – Motor Amp Setpoints


13. Motor Amp Spts hh:mm mon-dd-yy
Amp Reset=No Reset Active Spt =XXX%
Reset Signal=XX.Xma (*) Min Amp Spt =XXX%
Network Spt =XXXA (*) Max Amp Spt =XXX%

Menu 13, Screen 2 – Motor Amp Setpoints

13. Motor Amp Spts	**hh:mm mon-dd-yy**
Soft Load =Off	**(*) Dual Speed Spt = XXX%**
Begin Amp Lim= XX%	**(*)LagPDRateSpt = X.X°/M**
Ramp Time= XXMin	↓

Menu 23, Screen 1 – Dual / Network Setpoints

23. Dual / Net Spts	**hh:mm mon-dd-yy**
Slave Address=01.01	**Start-up=Unload**
LL Mode=Auto	**(*)LagStrtup DT=X.X°F**
LL SwOver=N/A 00:00	**(*) LagShtdnOffst= X.X°** ↓

Menu 26, Screen 3 – Unit Setup

26. Unit Setup	**hh:mm Mon-dd-yy**	
Full Load Amp = XX	**Hi Mtr Cur = Enable**	↑
(*) Vane Open Switch Yes	**No Str Tran = Enable**	
Low Mtr Cur = Enable	**Starter Flt = Enable**	↓

Table 11, MicroTech 200, VFD Setpoints

Item	Default Setpoints	Ranges	MicroTech Keypad Menu
Sample Time	10 Sec.	(1 to 63 Sec.)	Menu 11 Screen 2
Deadband	0.5%	(00.2 to 91%)	Menu 11 Screen 2
Mod Limit	2.5ºF	(1.0 to 10ºF)	Menu 11 Screen 2
Maximum Speed Steps	2%	(1 to 5%)	Menu 11 Screen 2
Motor Current	Set From Compressor Nameplate RLA	NA	Menu 26 Screen 3
Motor Current Threshold	5%	(1 to 20%)	Menu 22 Screen 3
Minimum Amp Setpoint	10%	(5 to 100%)	Menu 13 Screen 1
Maximum Amp Setpoint	100%	(0 to 100%)	Menu 13 Screen 1
Locked VFD Speed	On for Start-up /set up	(On / Off)	Menu 11 Screen 2
Locked VFD Speed	Off for VFD operation	(On / Off)	Menu 11 Screen 2
Locked Speed	100% for Start-up Set up	NA	Menu 11 Screen 2

NOTE: Setpoints shown above apply only to Menu 11, Screen 1, through Menu 26, Screen 3.

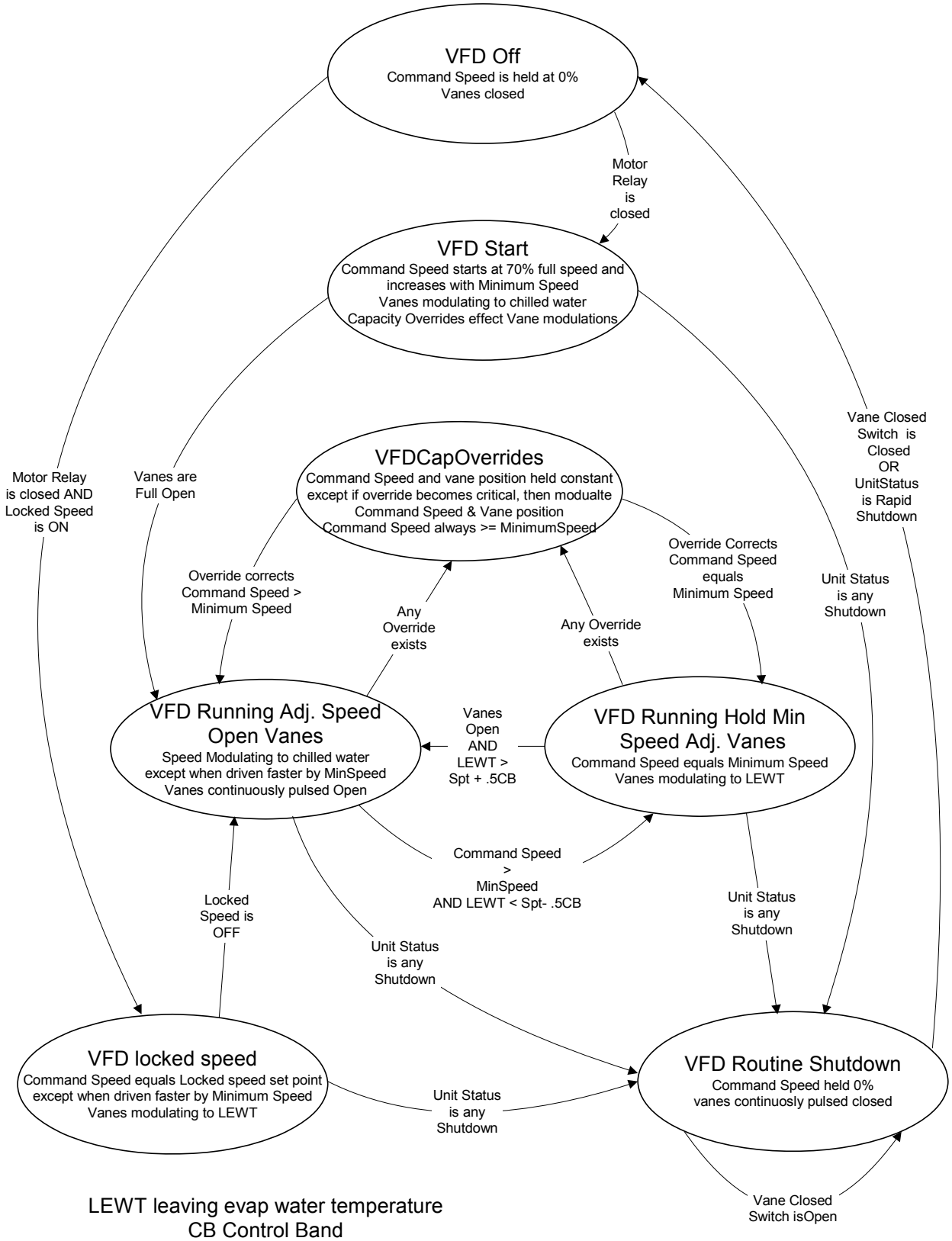
Table 12, MicroTech Unit Status vs VFD Status

Unit Status: MicroTech Menu 1 Screen 1	VFD Status: MicroTech Menu 1 Screen 2
All Systems Off	VFD Off
Off: Alarm	VFD Off
Off: Ambient Lockout	VFD Off
Off: Front Panel Switch	VFD Off
Off: Manual	VFD Off
Off: Remote Contacts	VFD Off
Off: Remote Communications	VFD Off
Off: Time Schedule	VFD Off
Start Requested	VFD Off
Waiting: Low Sump Temperature	VFD Off
Evaporator Pump Off	VFD Off
Evaporator Pump On: Recirculate (used for chillers)	VFD Off

Continued on next page.

Unit Status: MicroTech Menu 1 Screen 1	VFD Status: MicroTech Menu 1 Screen 2
Evaporator Pump On: Cycle Timers (used for chillers)	VFD Off
Evaporator Pump On: Waiting For Load (used for chillers)	VFD Off
Condenser Pump Off	VFD Off
Oil Pump Off	VFD Off
Oil Pump On: Pre-Lubrication	VFD Off
Condenser Pump On: Waiting for Flow	VFD Off
Evaporator Pump On: Waiting for Flow	VFD Off
Startup Unloading	VFD Off
MCR Started	VFD Start
Running OK -Or- Running Capacity Override Can have either VFD status shown to the right.	VFD Start Then, VFD Running; Hold Minimum Speed & Adjust Vanes VFD Running; Capacity Override Or- VFD Running; Adjust Speed & Open Vane
MCR Off: Rapid Shutdown	VFD Off
Shutdown: Unloading	VFD Routine Shutdown-Or-VFD Off
MCR Off: Routine Shutdown	VFD Off
Condenser Pump Off: Shutdown	VFD Off
Evaporator Pump Off Shutdown	VFD Off
Post Lubrication	VFD Off
Shutdown: Oil Pump Off	VFD Off

Figure 22, MicroTech 200 VFD Speed Control State Diagram


VFD Off
Command Speed is held at 0%
Vanes closed
Motor Relay is closed
VFD Start
Command Speed starts at 70% full speed and increases with Minimum Speed
Vanes modulating to chilled water
Capacity Overrides effect Vane modulations
Motor Relay is closed AND Locked Speed is ON
Vanes are Full Open
VFDCapOverrides
Command Speed and vane position held constant except if override becomes critical, then modualte Command Speed & Vane position
Command Speed always >= MinimumSpeed
Vane Closed Switch is Closed OR UnitStatus is Rapid Shutdown
Override corrects Command Speed > Minimum Speed
Any Override exists
Any Override exists
Override Corrects Command Speed equals Minimum Speed
Unit Status is any Shutdown
VFD Running Adj. Speed Open Vanes
Speed Modulating to chilled water except when driven faster by MinSpeed
Vanes continuously pulsed Open
Vanes Open AND LEWT > Spt + .5CB
VFD Running Hold Min Speed Adj. Vanes
Command Speed equals Minimum Speed
Vanes modulating to LEWT
Command Speed > MinSpeed AND LEWT < Spt- .5CB
Locked Speed is OFF
Unit Status is any Shutdown
Unit Status is any Shutdown
VFD locked speed
Command Speed equals Locked speed set point except when driven faster by Minimum Speed
Vanes modulating to LEWT
Unit Status is any Shutdown
VFD Routine Shutdown
Command Speed held 0%
vanes continuosly pulsed closed
Vane Closed Switch isOpen
LEWT leaving evap water temperature
CB Control Band

Capacity Overrides (Override Types Listed by Priority)

The following explains certain control functions and setpoints of interest.

NOTE: Stp = Setpoint

1. **Max Amp Limit**

   If the motor current is greater than 100% RLA, Hold Command Speed, pulse vanes closed for two seconds once every two minutes.

   If the motor current is greater than 105% RLA, If Command Speed is 10% greater than Minimum Speed, reduce Command Speed by 5%. If Command Speed is within 10% of Minimum Speed, reduce Command Speed by 2%. Close the vanes by one two-second pulse. Wait 15 seconds to see the if motor current corrects before repeating the process.

2. **Manual Loading**

   Manual Load setpoint is adjustable from the keypad display.

   If Manual Loading is Enabled.

   Pulse vanes open OR closed to drive the motor current %RLA to the Manual Load Setpoint.

3. **Minimum Amp Limit**

   Minimum Amp setpoint is adjustable from the keypad display.

   Range 5% to 100% in 1% increments. Default value is 10%.

   If the motor current %RLA is less than Minimum Amp Setpoint, hold vane position and command speed.

   If the motor current %RLA is 5% below the Minimum Amp Setpoint, open vanes and hold command speed.

4. **Manual Amp Limit**

   User defined capacity limit adjustable from the keypad display from 0% to 100%.

   If the motor current %RLA exceeds the Network setpoint, hold Command Speed and vane position.

   If the motor current %RLA is 5% greater than the Network setpoint, reduce command speed by 1% every five seconds. If the command speed should be reduced to minimum speed, close the vanes.

5. **Network Capacity Limit**

   Network provided capacity limit setpoint. The setpoint is limited in the software from 0% to 100%.

   If the motor current %RLA exceeds the Network setpoint, hold Command Speed and vane position.

   If the motor current %RLA is 5% greater than the Network setpoint, reduce command speed by 1% every five seconds. When the command speed is reduced to minimum speed, close the vanes.

6. **Max Pulldown Rate**

   Max Pull Down Rate setpoint is an adjustable setpoint

   (range 0.1 to 5.0°F/minute in 0.1°F increments, default is 1.0°F/minute)

   Pulldown rate = leaving evap. water temp one minute ago, minus leaving evap. water temp now.

   If the Pulldown rate exceeds the setpoint, hold command speed and vane position.

7. **Demand Limit**

   Establishes a demand limit between 10 and 100% RLA based on a 4-20 mA signal input.

   If the motor current %RLA is greater than the demand limit, hold command speed and vane position.

   If the motor current %RLA is 5% greater than the demand limit, reduce command speed by 1% every five seconds. If the command speed is reduced to Minimum Speed, close the vanes.

8. **Softloading**

   Establishes a soft load capacity limit between 10 and 100% RLA based on time from the first start of the day.

   If the motor current %RLA is greater than the soft load capacity, limit hold command speed and vane position.

   If the motor current %RLA is 5% greater than the soft load capacity, limit reduce command speed by 1% every five seconds. If Command Speed is reduced to Minimum Speed, close the vanes.

9. **Low Evap. Pressure**

   If the evaporator refrigerant pressure is less than 38.0 psi (default), hold speed and vane position.

   If the evaporator refrigerant pressure is less than 31.0 psi (default), hold speed and close vanes.

   Low evaporator pressure shutdown alarm setpoint is 26.0 psi (default).

Note: The above pressures must be set at unit design conditions.

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10. **High Discharge Temperature**

    If the discharge temperature is higher than 170º F, pulse the load solenoid if the vanes are not fully open.

    If the vanes are full open, increase command speed at the rate of 1% every five seconds.

General Description:

Figure 23, MicroTech II Operator Interface Panel 1

The following describes the software for centrifugal chillers with variable speed drive and the MicroTech II controller. Complete information on the MicroTech II controller operation is contained in the Operating Manual *OM CentrifMicro II*.

Variable Frequency Drive (VFD) Control:

Digital output NO1, (terminal J12) on the compressor controller is wired to the CR relay (Compressor Relay). The CR relay energizes the MCR (Motor Control Relay) which enables the variable frequency drive instead of a standard motor. Analog output Y1 (terminal J4) on the compressor controller provides the speed setpoint signal to the VFD. The output is a 0-10 VDC analog output signal, hard wired to the VFD.

Figure 24, MicroTech II Operator Interface Panel 2

There is no feedback signal required from the variable frequency drive to the MicroTech II controller to indicate the speed of the motor. The actual percent motor speed is within 1% of the analog output signal from the MicroTech II controller.

Digital Input ID9 (terminal J7) on the compressor controller is wired to the Vane Open switch (VO switch) that indicates when the vanes are 100% open. If the switch is open, the status of the vanes is Not Open. If the switch is closed, the status of the vanes is Open.

Or

If the compressor controller pulses a load output for the vanes to load for a cumulative time of 300 seconds (user adjustable), the MicroTech II controller will assume the compressor is fully loaded the same as if the V.O. switch closed (one unload pulse will reset the timer).

Sequence of Operation

Compressor Off:

The VFD is turned off, the speed output is 0%, and the vanes are closed. If the chiller is turned on and if there is a load, the chiller will go through its start sequence. The MCR will be energized, the speed signal will be set to minimum speed, and the VFD will start the compressor. When the compressor starts, it will be in the VFD Running, hold speed, adjust vanes mode.

VFD Running, Hold Minimum Speed, Adjust Vanes:

The VFD remains on, the command speed is held at Minimum Speed, and the vanes are modulated to maintain the Active LEWT Setpoint. As the load increases; if the vane open switch closes or the MicroTech II controller pulses the vanes open for a cumulative 300 seconds (default), and the LEWT is greater than the active setpoint, the mode switches to "VFD Running Adjust Speed, Open Vanes". Otherwise, the controller stays in this mode with the speed at Minimum Speed and the vanes being controlled to satisfy the Active LEWT Setpoint.

VFD Running, Adjust Speed, Open Vanes:

The VFD remains on, the speed output is modulated to maintain the Active LEWT Setpoint, and the vanes are driven to the open position. As the load decreases, if the speed equals the lift temperature control speed and the LEWT is less than the active LEWT setpoint, the mode switches to "VFD Running, Hold Minimum Speed, Adjust Vanes". Otherwise, the controller stays in this mode.

Compressor Shutdown:

The VFD remains on, the speed output remains constant, and the vanes are driven closed (shutdown unload state). This state is used during a routine shutdown of the chiller. If there is a rapid shutdown caused by a fault alarm, the MCR will be immediately de-energized, the speed signal will go to zero, and the compressor state will go directly to Postlube.

WDC, Dual Compressor VFD Operation

The MicroTech II controller has the capability to control a dual compressor VFD chiller or multiple stand alone VFD chillers with interconnecting network communications, including all compressor staging and load balance functions. (See *OMCentrifMicro II* for set up of multiple compressor staging).

General Dual Compressor VFD Operation

The first compressor starts and runs as a single VFD compressor controlling speed and vane position based on LEWT (Leaving Evaporator Water Temperature). When the capacity of the first compressor reaches "Full Load" and LEWT is greater than stage delta, and the slope (pull down rate) is less than the user adjustable minimum rate setpoint, the next compressor will be enabled.

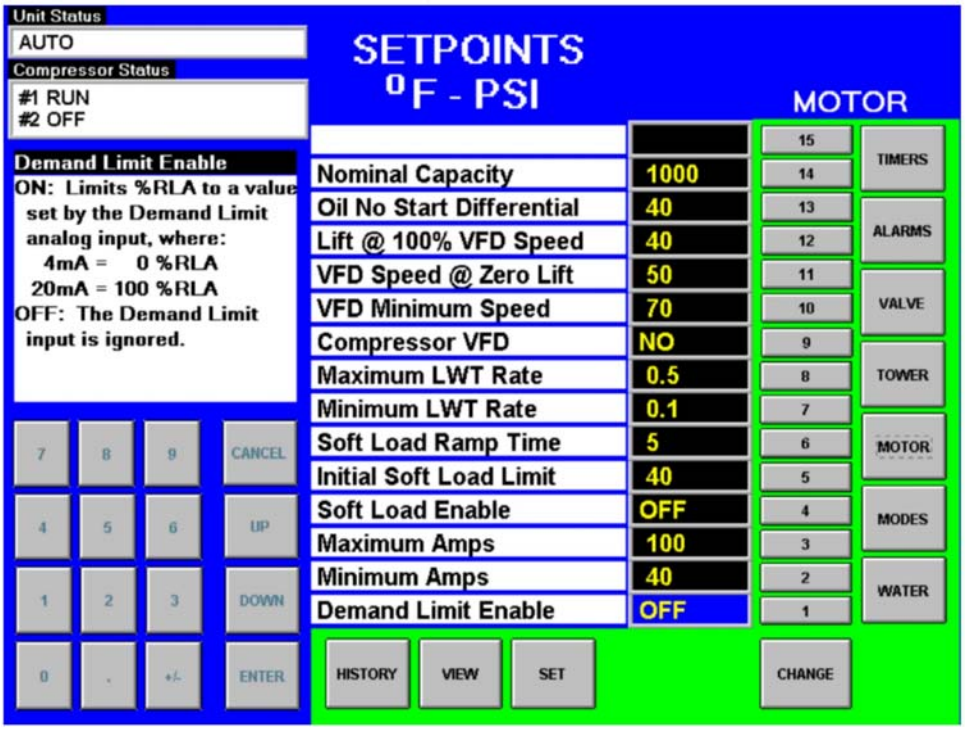
Dual Compressor Unit Stage Down

When "Compressor Capacity" exceeds calculated system load (internal algorithm), the "next off" compressor will be disabled. When the "next off" compressor is disabled, the controller will unload the compressor by closing the vanes (shutdown unload) to unload the compressor. The load balance function will make the other compressor follow. When the shutdown unload timer expires, or the vane close switch closes (which ever occurs first), the MCR will de-energized, and the controller will transition to the post lube sequence. At the end of the post lube timer, the oil pump will be turned off and the controller will transition to the off sequence.

Interface Panel Screens, MT II

NOTE: This section contains the MicroTech II controller and Operator Interface Panel display screens. Figure 25 is the setpoint screen on the initial production panel (Panel 1). Figure 26 shows the screen used on the second issue panel (Panel 2) that went into production mid-2005.

Figure 25, MOTOR (VFD) Setpoint Screen, Panel 1



VFD related settings are #9 through #12.

Password: **T** = Technician Level, **M** = Manager Level, **O** = Operator Level

Description	No.	Default	Range	Password	Comments
Nominal Capacity	14	Design	0 to 9999 Tons		Determines when to shut off a compressor
Oil No Start Diff (above Evap Temp)	13	40 °F	30 to 60 °F	T	Minimum Delta-T between oil sump temperature and saturated evaporator temperature
Lift @ Max Speed	12	40 °F	30 to 60 °F	T	Temp lift at 100 % speed (cond sat – evap sat temp)
Speed @ 0 Lift	11	50%	0 to 100%	T	Lift @ min speed as a % of 100 % lift. SP 10 has priority over this setting.
Minimum Speed	10	70%	60 to 100%	T	Min VFD speed, has priority over SPs 11 & 12
VFD	9	No	No, Yes	T	VFD on unit or not
Maximum Rate	8	0.5 °F/min	0.1 to 5.0 °F/min	M	Inhibits loading if LWT change exceed the setpoint value.
Minimum Rate	7	0.1 °F/min	0.0 to 5.0 °F/min	M	Additional compressor can start if LWT change is below setpoint.
Soft Load Ramp	6	5 min	1 to 60 min	M	Time period to go from initial load point (% RLA) set in SP 5 to 100% RLA
Initial Soft Load Amp Limit	5	40%	20 to 100%	M	Initial amps as % of RLA. Used with SP 4 and SP 6
Soft Load Enable	4	OFF	OFF, ON	M	Soft load on (using SP 5 and SP 6) or off
Maximum Amps	3	100%	40 to 100%	T	% RLA above which loading is inhibited (Load Limit) Unloading is forced at 5% above this value.
Minimum Amps	2	40%	20 to 80%	T	% RLA below which unloading is inhibited
Demand Limit Enable	1	OFF	OFF, ON	O	ON sets %RLA at 0% for 4 mA external signal and at 100% RLA for 20 mA signal

NOTE: Shaded settings are VFD related.

Figure 26, MOTOR (VFD) Setpoint Screen, Panel 2

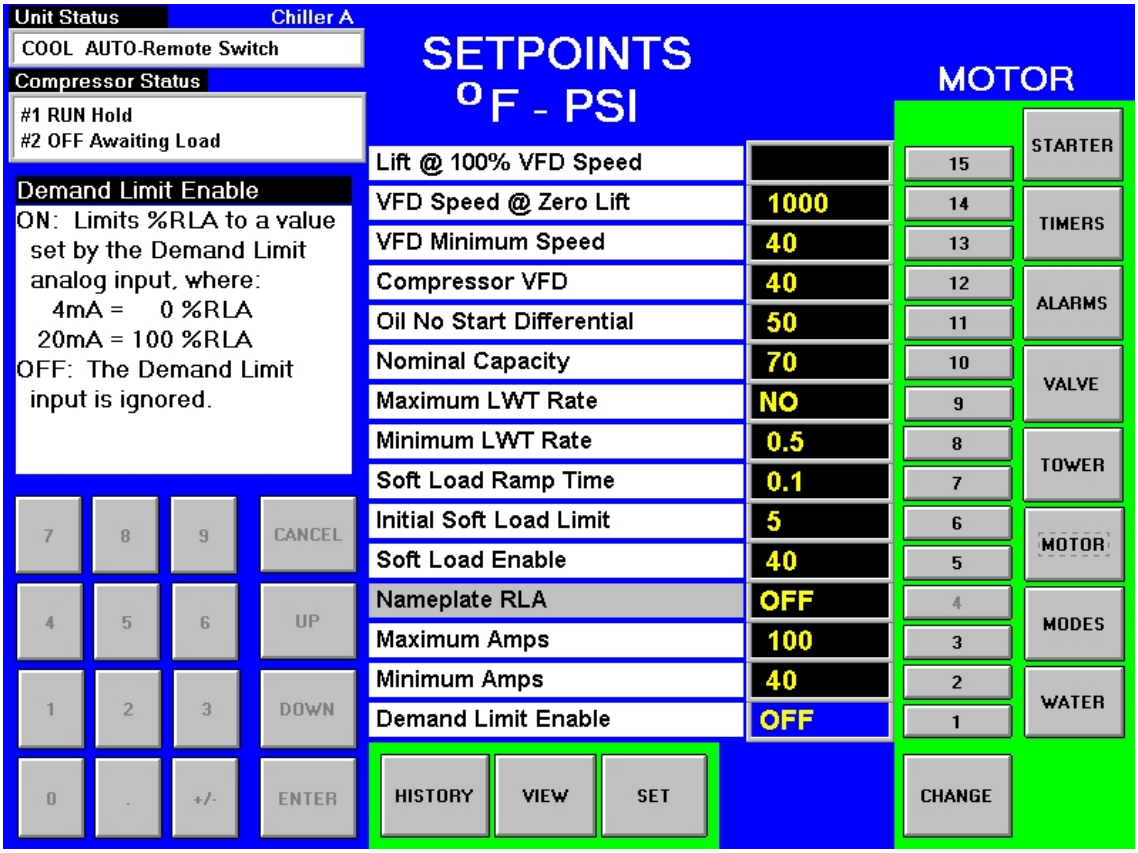


Table 13, MOTOR Setpoint Settings

VFD related settings are #12 through #15.

Password: **T** = Technician Level, **M** = Manager Level, **O** = Operator Level

Description	No.	Default	Range	Password	Comments
Lift @ Max VFD Speed	15	40 °F	30 to 60 °F	T	Temp lift at 100 % speed (cond sat – evap sat temp)
VFD Speed @ 0 Lift	14	50%	0 to 100%	T	Lift @ min speed as a % of 100 % lift. SP 10 has priority over this setting.
VFD Minimum Speed	13	70%	60 to 100%	T	Min VFD speed, has priority over SPs 11 & 12
VFD	12	No	No, Yes	T	VFD on unit or not
Oil No Start Diff (above Evap Temp)	11	40 °F	30 to 60 °F	T	Minimum Delta-T between oil sump temperature and saturated evaporator temperature
Nominal Capacity	10	Design	0 to 9999 Tons		Determines when to shut off a compressor, factory set
Maximum LWT Rate	9	0.5 °F/min	0.1 to 5.0 °F/min	M	Inhibits loading if LWT change exceed the setpoint value.
Minimum LWT Rate	8	0.1 °F/min	0.0 to 5.0 °F/min	M	Additional compressor can start if LWT change is below setpoint.
Soft Load Ramp Time	7	5 min	1 to 60 min	M	Time period to go from initial load point (% RLA) set in SP 5 to 100% RLA
Initial Soft Load Amp Limit	6	40%	20 to 100%	M	Initial amps as % of RLA. Used with SP 4 and SP 6
Soft Load Enable	5	OFF	OFF, ON	M	Soft load on (using SP 5 and SP 6) or off
Nameplate RLA	4	N.A.	N.A.	N.A.	Not used on these chillers
Maximum Amps	3	100%	40 to 100%	T	% RLA above which loading is inhibited (Load Limit) Unloading is forced at 5% above this value.
Minimum Amps	2	40%	20 to 80%	T	% RLA below which unloading is inhibited
Demand Limit Enable	1	OFF	OFF, ON	O	ON sets %RLA at 0% for 4 mA external signal and at 100% RLA for 20 mA signal

Setpoint 11 on Panel 1 (setpoint 14 on Panel 2) sets the % speed at 0 degrees F Lift, point A in Figure 25.

Setpoint 12 on Panel 1 (setpoint 15 on Panel 2) sets the lift in degrees F at the 100 % speed point, point B in Figure 26.

Figure 27, Operating Envelope, Setpoints 11 and 12 Settings

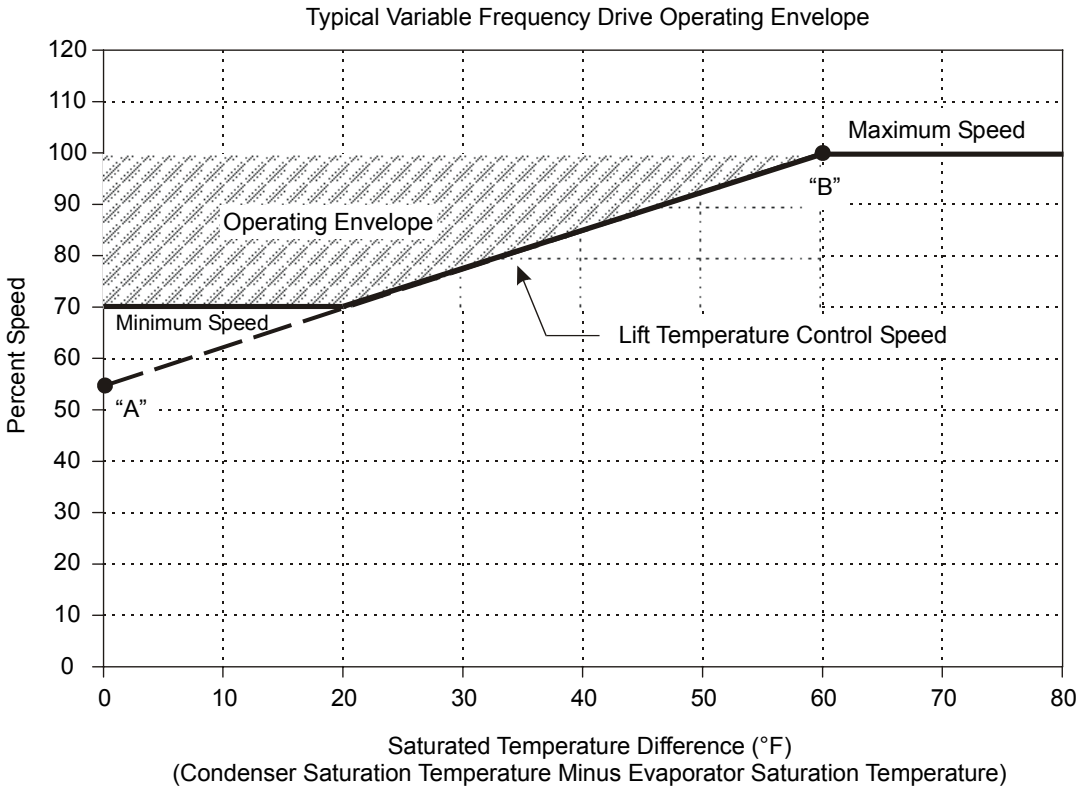


Figure 28, View I/O Screen

The MicroTech II controller View I/O Screen, shown to the right, displays the compressor motor speed, as controlled by the VFD, at the bottom of the screen. This is information only and no settings are made on this screen.

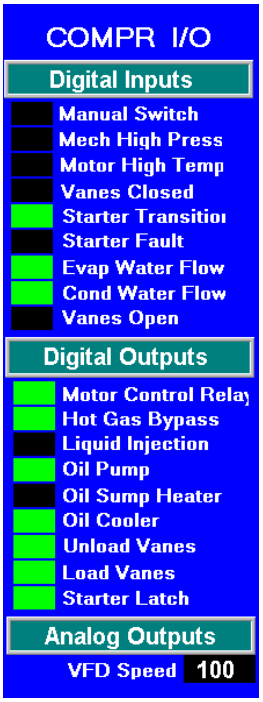


Table 14, MicroTech II, Settings and Ranges (Single Compressor)

MicroTech II VFD	Default Setpoint	Range	Keypad Location	OITS Locations
Motor Current	Comp. Nameplate RLA	N.A.	UC-SC-(4)	N/A
Motor Current Threshold (1)	5%	1 to 20%	UC-SA-(4)	Set-Alarms-(12)
Minimum Amp Setpoint (2)	10%	5 to 100%	UC-SC-(1)	Set -Motor-(2)
Maximum Amp Setpoint	100%	0 to 100%	UC-SC-(1)	Set -Motor-(3)
VFD	Yes	yes/no	UC-SU-(10)	Set -Motor-(9)
Minimum Speed	70%	70 to 100%	UC-SU-(10)	Set -Motor-(10)
Speed	50% (@ 0°F lift, "Y" axis	Setpoint 11 on Panel 1 (setpoint 14 on Panel 2) sets the % speed at 0 degrees F Lift, point A in Figure 25.	UC-SU-(10)	Set -Motor-(11)
Lift	40°F (@100% speed, X axis	Setpoint 12 on Panel 1 (setpoint 15 on Panel 2) sets the lift in degrees F at the 100 % speed point, point B in Figure 26.	UC-SU-(10)	Set -Motor-(12)

NOTES:

1. Motor Current Threshold, current at which a low current fault occurs.
2. Minimum Amp Setpoint, Minimum unloading amp setpoint.
3. The OITS is the preferred place to adjust setpoints. The unit controller is the second choice and the compressor controller should never be used.

Table 15, MicroTech II, Settings and Ranges (Multiple Compressor Includes Duals)

MicroTech II VFD	Default Setpoints	Range	Keypad	OITS Locations
Max Comp. On	2 for Dual	1 to 16	UC-SC-(2)	Modes-(9)
Stage Delta	1°F	0.5 to 5.0°F	UC-SC-(3)	Water-(6)
Nominal Capacity	Unit Design Tons	N.A.	UC-SC-(5)	Motor-(14)
Unload Timer (1)	030 sec	10 to 240 sec.	UC-SC-(6)	Timers-(6)
Min LWT Rate	0.1°F	0.0 to 5.0°F	UC-SU-(7	Motor-(7)

NOTE: 1. This must be set longer than the mech. vane speed to unload the compressor.

Code: UC = Unit Controller; CC = Compressor Controller; OITS = Operator Interface Touch Screen; V = View Menu Keypad or OITS Screen; A = Alarm Menu Keypad Or OITS Screen; S = Set Menu Keypad or OITS Screen; C = Compressor Menus; U = Unit Menus

Example:

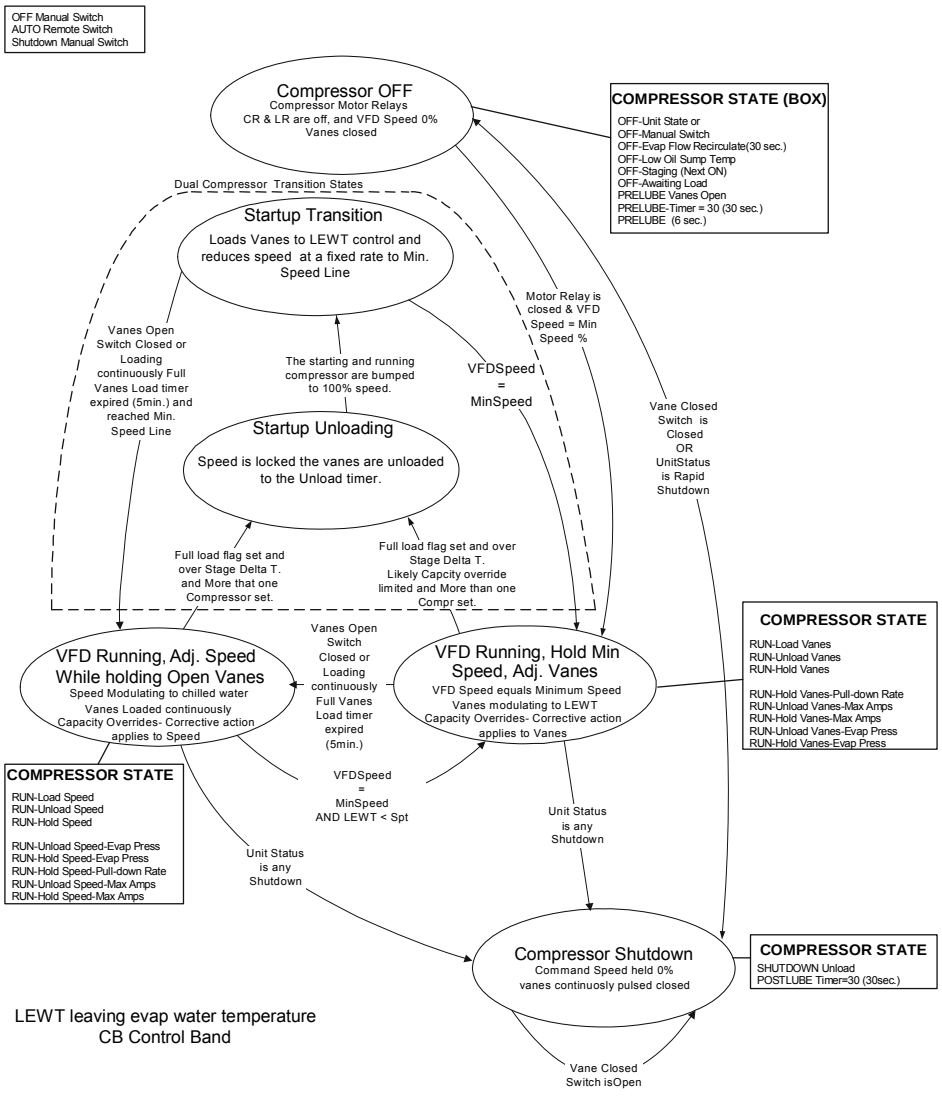
Setpoint location for VFD Minimum speed = UC-SU-(10). The location would be the Unit Controller, Set Unit Setpoints Menu, Screen 10. OITS locations are S = Setpoint screen, "Alarms" or "Motor", and the number of the setpoint on the screen.

Additional Setpoints, the following two setpoints are at Technician level and are located at UC-SC-(8) and not on the OITS. They are for exclusive use of factory trained service technicians.

VFD Mode = Auto (auto/manual), this allows the VFD speed output signal to be manually controlled for testing, or to be automatic for normal operation. The MicroTech II controller will not allow the speed signal to go below the calculated lift control speed.

VFD Speed Manual Setpoint = 100%, when the unit is started for the first time, and set up for design, or to check the operation and performance of the unit, it is necessary to run the unit at a constant fixed speed of 100%. To accomplish this, set the VFD Minimum Speed to 100% [UC-SU-(10) or OITS-S-Motor-(10)], then set up and adjust the unit. When testing is complete, set the minimum speed back to the original setpoint. Do not set the drive minimum speed to 100% to set up or test the unit at full speed, as the controller will not know that the drive will not respond to it's speed signal. The controller will try to control the LEWT setpoint with speed and a control conflict will result.

Figure 29, MicroTech II VFD Speed Control State Diagram


OFF Manual Switch
AUTO Remote Switch
Shutdown Manual Switch
Compressor OFF
Compressor Motor Relays
CR & LR are off, and VFD Speed 0%
Vanes closed
COMPRESSOR STATE (BOX)
OFF-Unit State or
OFF-Manual Switch
OFF-Evap Flow Recirculate(30 sec.)
OFF-Low Oil Sump Temp
OFF-Staging (Next ON)
OFF-Awaiting Load
PRELUBE Vanes Open
PRELUBE-Timer = 30 (30 sec.)
PRELUBE (6 sec.)
Dual Compressor Transition States
Startup Transition
Loads Vanes to LEWT control and reduces speed at a fixed rate to Min. Speed Line
Motor Relay is closed & VFD Speed = Min Speed %
Vanes Open Switch Closed or Loading continuously Full Vanes Load timer expired (5min.) and reached Min. Speed Line
The starting and running compressor are bumped to 100% speed.
VFDSpeed = MinSpeed
Vane Closed Switch is Closed OR UnitStatus is Rapid Shutdown
Startup Unloading
Speed is locked the vanes are unloaded to the Unload timer.
Full load flag set and over Stage Delta T. and More that one Compressor set.
Full load flag set and over Stage Delta T. Likely Capcity override limited and More than one Compr set.
COMPRESSOR STATE
RUN-Load Vanes
RUN-Unload Vanes
RUN-Hold Vanes
RUN-Hold Vanes-Pull-down Rate
RUN-Unload Vanes-Max Amps
RUN-Hold Vanes-Max Amps
RUN-Unload Vanes-Evap Press
RUN-Hold Vanes-Evap Press
VFD Running, Adj. Speed While holding Open Vanes
Speed Modulating to chilled water
Vanes Loaded continuously
Capacity Overrides- Corrective action applies to Speed
Vanes Open Switch Closed or Loading continuously Full Vanes Load timer expired (5min.)
VFD Running, Hold Min Speed, Adj. Vanes
VFD Speed equals Minimum Speed
Vanes modulating to LEWT
Capacity Overrides- Corrective action applies to Vanes
COMPRESSOR STATE
RUN-Load Speed
RUN-Unload Speed
RUN-Hold Speed
RUN-Unload Speed-Evap Press
RUN-Hold Speed-Evap Press
RUN-Hold Speed-Pull-down Rate
RUN-Unload Speed-Max Amps
RUN-Hold Speed-Max Amps
VFDSpeed = MinSpeed AND LEWT < Spt
Unit Status is any Shutdown
Unit Status is any Shutdown
Compressor Shutdown
Command Speed held 0%
vanes continuosly pulsed closed
COMPRESSOR STATE
SHUTDOWN Unload
POSTLUBE Timer=30 (30sec.)
LEWT leaving evap water temperature
CB Control Band
Vane Closed Switch isOpen

Notes:

1. The above pressures must be set at unit design conditions.
2. Low evaporator pressure shutdown alarm setpoint is 26.0 psi (default)
3. If the discharge temperature is higher than 170º F, pulse the load solenoid if the vanes are not fully open.

Operation, Small A/C SP600 & LF 2.0

The SP600 and LF 2.0 VFDs share the same interface modules and their operation is the same except for some differences in parameters, (which are outside the purview of this manual) and differences in some faults and alarms. The faults and alarms are given separately later in this section.

⚠ Warning

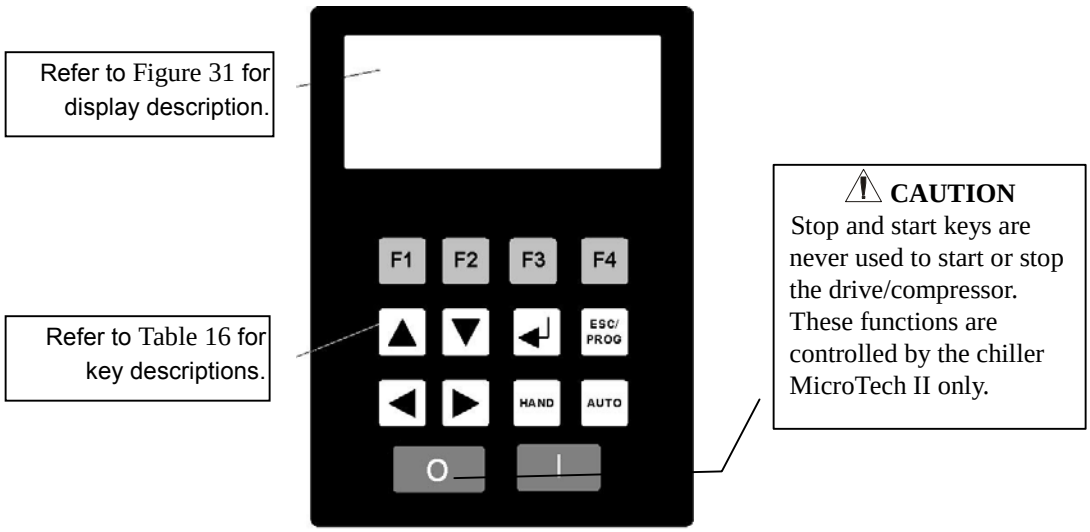
Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

The status of the drive can be viewed on the Operator Interface Module (OIM) or on various LEDs.

Using the Interface

The LCD Operator Interface Module is a keypad/display that enables programming, monitoring, and controlling the drive.

Figure 30, Operator Interface Module



Powering Up and Adjusting the LCD OIM

- The first time the LCD OIM is powered up, you will be prompted to select a language for the display text. If the Start-Up routine has not been completed, the Start-Up menu is displayed immediately following the language selection screen.

Selecting the Fast Power Up Feature

- The fast power up feature bypasses the initialization screen at power up, and the Main Menu is displayed immediately. To select this feature, select Fast PwrUp Mode from the Display menu.

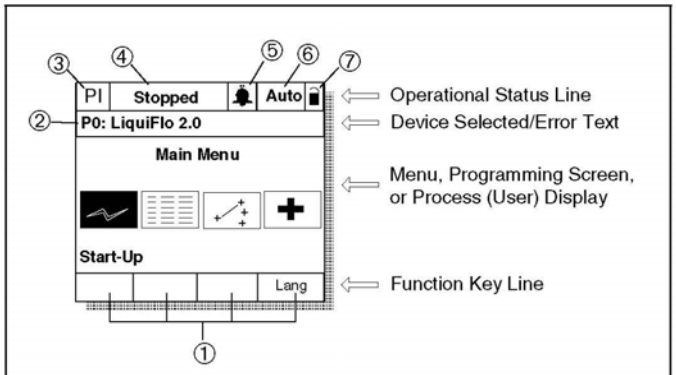
Adjusting the Screen Contrast

- To adjust the screen contrast, select Contrast from the Display menu.

Resetting the Display

- Do not reset the display to "factory settings" as these may be the display manufacturer's settings and not the McQuay factory settings.

Figure 31, Display Description



①	Function Key (F1, F2, F3, F4) definitions
②	Port/peripheral identification. Identifies port or peripheral on DPI about which the OIM is displaying information. See section B.5.
③	PI loop status: PI = PI control is active.
④	Operating status (for example, Running, Stopped, etc.)
⑤	Alarm annunciation. = Alarm has occurred.
⑥	Auto/Hand mode status.
⑦	Write-protect password status: (unlocked) = password disabled; (locked) = password enabled. See section 8.4

Table 16, Key Descriptions

Key	Function
◀	Scroll through options or user function keys, move cursor to the left.
▶	Scroll through options or user functions keys, move cursor to the right.
▲	Scroll through options, increase a value, or toggle a bit.
▼	Scroll through options, decrease a value, or toggle a bit.
ESC/PROG	Exit a menu, cancel a change to a parameter, or toggle between program and process (user) display screens.
↵	Enter a menu, select an option, or save changes to parameter value
HAND	Enable Hand (manual) reference control.
AUTO	Release Hand (manual) reference control.
○	Stop the drive. Clear a fault if the OIM is the control source.
|	Start the drive if the OIM is the control source.
F1	F1 though F4: Predefined or user-configured functions. The definition of each key is shown directly above the key on the display. See item □ in figure B.3.

From the main menu, use the ◀ or ▶ keys to scroll through the sub menus. The Diagnostics menu is if primary interest to the operator. When selected, press the Enter key,

to select it. Then use the scroll keys, up, down, right, or left, to select the item of interest.

Using the LEDs

Determining Precharge Board Status Using the LED Indicators (Frames 5 & 6 Only)

Precharge is an internal function that is used automatically when powering up the control. There is no operator function required. Precharge LEDs give the status of the board. They are located above the Line Type jumper shown in Figure 32.

In addition to the LED signal, a fault in the precharge function will also show on the display.

Figure 32, Location of Precharge Status LED

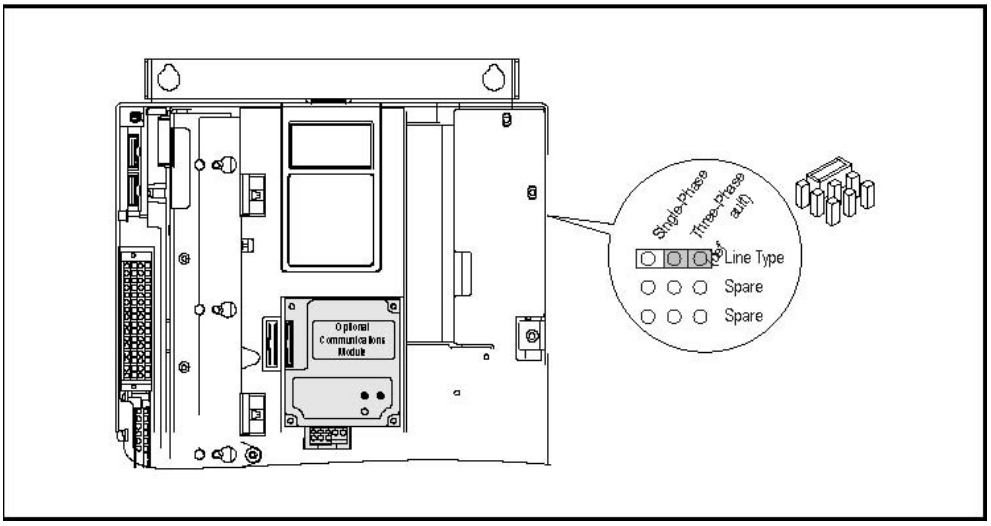


Table 17, Precharge Board LED Indicators

Name	Color	State	Description
Power ON	Green	Steady	Indicates when pre-charge board power supply is operational
Alarm	Yellow	Steady	Indicates one of the following alarms occurred causing the pre-charge to momentarily stop firing: • Line Loss • Low Phase (single-phase dropped below 80% of line voltage) • Input frequency out of range (momentarily) **Note**: An alarm condition automatically resets when the condition no longer exists
Fault	Red	Steady	Indicates one of the following faults: • DC Bus short • DC Bus not charged • Input frequency out of range • Overtemperature **Note**: A fault indicates a malfunction that needs to be corrected prior to restarting. A fault condition is only reset after cycling power.

LED Drive Status

Figure 33, Location of the Ready LED

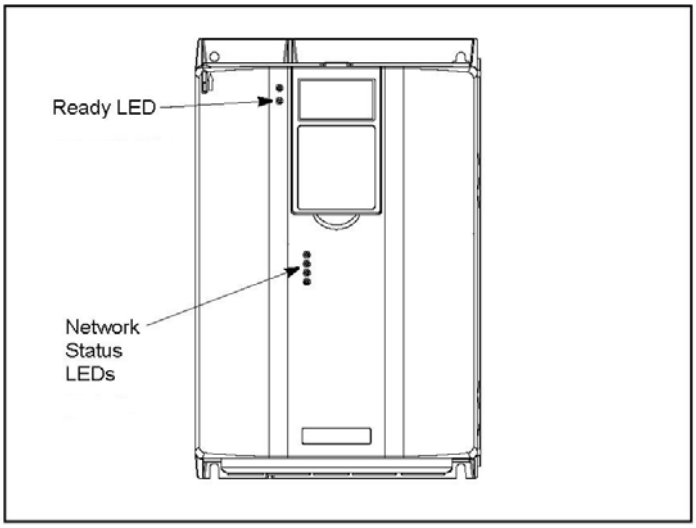


Table 18, Ready LED Status Functions

Color	State	Description
Green	Flashing	Drive ready, but not running and no faults are present.
	Steady	Drive running, no faults are present.
Yellow	Flashing	The drive is not ready. Check parameter 214 (Start Inhibits).
	Steady	An alarm condition exists. Check parameters 211 (Drive Alarm 1) and 212 (Drive Alarm 2).
Red	Flashing	An alarm condition exists. Check parameters 211 (Drive Alarm 1) and 212 (Drive Alarm 2).
	Steady	A fault has occurred.

Determining Drive Status Using the Status LEDs

Two status LEDs are located on the DPI Communications Interface board on the front of the power module. The LEDs indicate of the status of the inverter and the rectifier. Note that if the LEDs are off, it indicates it is not receiving power.

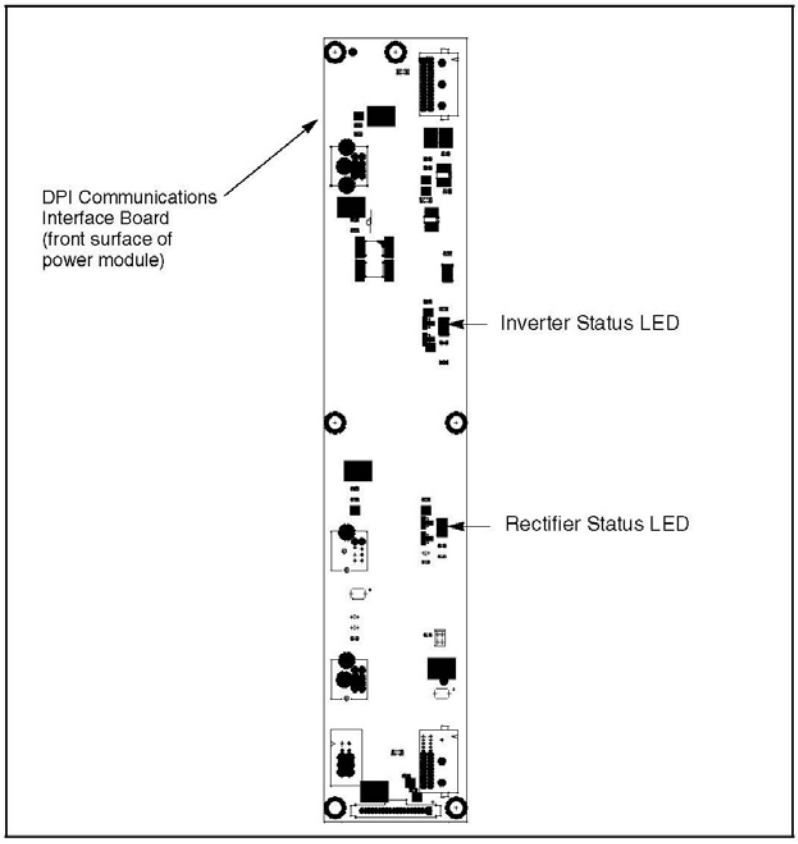


Table 19, Status LED Definitions

Color	State	Description

Green	Flashing	Drive ready, but not running and no faults are present.
	Steady	Drive running, no faults are present.
Yellow	Flashing	The drive is not ready. Check parameter 214 (Start Inhibits).
	Steady	An alarm condition exists. Check parameters 211 (Drive Alarm 1) and 212 (Drive Alarm 2).
Red	Flashing	A fault has occurred
	Steady	A non-resettable fault has occurred.

About Alarms

Alarms indicate conditions that may affect drive operation or application performance. There are two alarm types, as described in Table 20. Alarms do not shut down a unit, but often lead to a :fault that will.

Table 20, Types of Alarms

Type	Alarm Description	
1	User-Configurable	These alarms alert the operator of conditions that, if left untreated, may lead to a fault condition. The drive continues to operate during the alarm condition. The alarms are enabled or disabled using Alarm Config 1 (259). The status of these alarms is shown in Drive Alarm 1 (211).
2	Non-Configurable	These alarms alert the operator of conditions caused by improper programming and prevent the drive from starting until the problem is resolved. These alarms are always enabled. The status of these alarms is shown in Drive Alarm 2 (212).

The drive indicates alarm conditions in the following ways:

- Yellow LED visible from the front of the drive.
- Ready LED on the drive cover (see Table 18).
- Alarm name and bell graphic on the LCD OIM. The alarm is displayed as long as the condition exists. The drive automatically clears the alarm when the condition causing it is removed.
- Alarm status parameters. Two 16-bit parameters, Drive Alarm 1 (211) and Drive Alarm 2 (212), indicate the status of type 1 and type 2 alarms, respectively.
- No external signal is available for alarms.

About the Alarm Queue

The drive automatically retains a history of alarms that have occurred in the alarm queue. The alarm queue is accessed using the OIM or PC software.

The alarm queue holds the eight most recent alarms. The last alarm to occur is indicated in queue entry #1. As new alarms are logged into the queue, existing alarm entries are shifted (for example, entry #1 will move to entry #2). Once the queue is full, older alarms are discarded from the queue as new alarms occur.

All entries in the alarm queue are retained if power is lost. Alarms are automatically cleared when the alarm condition goes away.

The alarm queue can be cleared using the OIM by selecting “Clr Alarm Queue”, or by using a PC software tool.

Alarm Descriptions

Table 21, Alarm Descriptions, SP600

<table>
<tr><th>Alarm</th><th>Type</th><th>Description</th></tr>
<tr><td>Analog In Loss</td><td>1</td><td>An analog input is configured for alarm on signal loss and signal loss has occurred.</td></tr>
<tr><td>Bipolar Conflict</td><td>2</td><td>Parameter 190 (Direction Mode) is set to Bipolar or Reverse Dis and one of more of the following digital input functions is configured: Fwd/Rev or Run Fwd. Note that the default is Reverse Dis.</td></tr>
<tr><td>Decel Inhibit</td><td></td><td>The drive is being inhibited from decelerating.</td></tr>
<tr><td>Dig In ConflictA</td><td>2</td><td>Digital input functions are in conflict. Combinations marked with an (X) will cause an alarm.
<table>
<tr><td></td><td>Acc2 / Dec2</td><td>Accel 2</td><td>Decel 2</td><td>Fwd / Rev</td></tr>
<tr><td>Acc2 / Dec2</td><td></td><td>X</td><td>X</td><td></td></tr>
<tr><td>Accel 2</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Decel 2</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Fwd / Rev</td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Dig In ConflictB</td><td>2</td><td>Digital input functions are in conflict. Combinations marked with an (X) will cause an alarm
<table>
<tr><td></td><td>Start</td><td>Stop–CF</td><td>Run</td><td>Run Fwd</td><td>Fwd/Rev</td></tr>
<tr><td>Start</td><td></td><td></td><td>X</td><td>X</td><td></td></tr>
<tr><td>Stop–CF</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Run</td><td>X</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>Run Fwd</td><td>X</td><td></td><td>X</td><td></td><td>X</td></tr>
<tr><td>Fwd / Rev</td><td></td><td></td><td></td><td>X</td><td></td></tr>
</table></td></tr>
<tr><td>Dig In ConflictC</td><td>2</td><td>More than one physical input has been configured to the same input function. Multiple configurations are not allowed for the following input functions:
<table>
<tr><td>Forward/Reverse</td><td>Run</td><td>Bus Regulation Mode B</td></tr>
<tr><td>Speed Select 1</td><td>Stop Mode B</td><td>Acc2 / Dec2</td></tr>
<tr><td>Speed Select 2</td><td>OIM Control</td><td>Accel 2</td></tr>
<tr><td>Speed Select 3</td><td>Stop Mode B</td><td>Decel 2</td></tr>
<tr><td>Run Forward</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>DigIn Bad Value</td><td>2</td><td>Unsupported function selected in Digital In”x” Sel parameters (361-366).</td></tr>
<tr><td>Drive OL Level 1</td><td>1</td><td>The calculated IGBT temperature requires a reduction in PWM carrier frequency. If Drive OL Mode (150) is disabled and the load is not reduced, an overload fault will eventually occur.</td></tr>
<tr><td>Drive OL Level 2</td><td>1</td><td>The calculated IGBT temperature requires a reduction in Current Limit. If Drive OL Mode (150) is disabled and the load is not reduced, an overload fault will eventually occur.</td></tr>
<tr><td>Flux Amps Ref Rang</td><td>2</td><td>Result of autotune procedure (61).</td></tr>
<tr><td>IntDBRes OvrHeat</td><td>1</td><td>The drive has temporarily disabled the dynamic braking regulator because the resistor temperature has exceeded a predetermined value.</td></tr>
<tr><td>IR Volts Range</td><td>2</td><td>The drive autotuning default is Calculate and the value calculated for IR Drop Volts is not in the range of acceptable values. This alarm should clear when all motor nameplate data is properly entered.</td></tr>
<tr><td>Ixo Vlt Rang</td><td></td><td>Motor leakage inductance is out of range.</td></tr>
<tr><td>MaxFreq Conflict</td><td>2</td><td>The sum of Maximum Speed (82) and Overspeed Limit (83) exceeds Maximum Freq (55). Raise Maximum Freq (55) or lower Maximum Speed (82) and/or Overspeed Limit (83) so that the sum is less than or equal to Maximum Freq (55).</td></tr>
</table>

Continued on next page.

Alarm	Type	Description
Motor Type Cflct	2	Motor Type (40) has been set to Sync Prm Mag or Sync Reluc, and one or more DC functions (for example, DC Boost, DC Brake, etc.) have been activated. DC injection functions are imcompatible with synchronous motors and may demagnetize them.
NP Hz Conflict	2	Fan/pump mode is selected in Torq Perf Mode (53), and the ratio of Motor NP Hertz (43) to Maximum Freq (55) is greater than 26.
Power Loss	1	Drive has sensed a power line loss.
Prechrg Actv	1	Drive is in the initial DC bus precharge state.
Sleep Config		Sleep/Wake configuration error. When Sleep-Wake Mode [178] = Direct, possible causes include: - Drive is stopped and Wake Level [180] < Sleep Level [182] - Digital Inx Sel [361 to 366] is not set to one of the following: Stop=CF, Run, Run Forward, or Run Reverse.
Speed Ref Cflct	2	Speed Ref A Sel (90) or PI Reference Sel (126) is set to Reserved.
Under-Voltage	1	The bus voltage has dropped below a predetermined value.
VHz Neg Slope	2	Custom V/Hz mode has been selected in Torq Perf Mode (53) and the V/Hz slope is negative.
Waking		The wake timer is counting toward a value that will start the drive.

Table 22, Alarm Descriptions (LF 2.0

NOTE: Type, 1=Auto-resettable 2=Non-resettable 3=User-configurable

<table>
<tr><th>Alarm</th><th>Type</th><th>Description</th></tr>
<tr><td>Analog In Loss</td><td>1</td><td>An analog input is configured for alarm on signal loss and signal loss has occurred.</td></tr>
<tr><td>Bipolar Conflict</td><td>2</td><td>Parameter 190 (Direction Mode) is set to Bipolar or Reverse Dis and one of more of the following digital input functions is configured: Fwd/Rev, Run Fwd, Run Rev, Jog Fwd, or Jog Rev.</td></tr>
<tr><td rowspan="9">Dig In ConflictA</td><td rowspan="9">2</td><td>Digital input functions are in conflict. Combinations marked with a will cause an alarm.</td></tr>
<tr><td>
<table>
<tr><th></th><th>Acc2/ Dec2</th><th>Accel2</th><th>Cecel2</th><th>Jog</th><th>Jog Fwd</th><th>Jog Rev</th><th>Fwd/R ev</th></tr>
<tr><td>Acc2/Dec2</td><td></td><td>x</td><td>x</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Accel2</td><td>x</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cecel2</td><td>x</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jog</td><td></td><td></td><td></td><td></td><td>x</td><td>x</td><td></td></tr>
<tr><td>Jog Fwd</td><td></td><td></td><td></td><td>x</td><td></td><td></td><td>X</td></tr>
<tr><td>Jog Rev</td><td></td><td></td><td></td><td>x</td><td></td><td></td><td>x</td></tr>
<tr><td>Fwd/Rev</td><td></td><td></td><td></td><td></td><td>x</td><td>x</td><td></td></tr>
</table>
</td></tr>
<tr><td rowspan="11">Dig In ConflictB</td><td rowspan="11">2</td><td>Digital input functions are in conflict. Combinations marked with a will x cause an alarm.</td></tr>
<tr><td>
<table>
<tr><th></th><th>Start</th><th>Stop -CF</th><th>Run</th><th>Run Fwd</th><th>Run Rev</th><th>Jog</th><th>Jog Fwd</th><th>Jog Rev</th><th>Fwd/ Rev</th></tr>
<tr><td>Start</td><td></td><td></td><td>x</td><td>x</td><td>x</td><td></td><td>x</td><td>x</td><td></td></tr>
<tr><td>Stop-CF</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Run</td><td>x</td><td></td><td></td><td>x</td><td>x</td><td></td><td>x</td><td>x</td><td></td></tr>
<tr><td>Run Fwd</td><td>x</td><td></td><td>x</td><td></td><td></td><td>x</td><td></td><td></td><td>x</td></tr>
<tr><td>Run Rev</td><td>x</td><td></td><td>x</td><td></td><td></td><td>x</td><td></td><td></td><td>x</td></tr>
<tr><td>Jog</td><td></td><td></td><td></td><td>x</td><td>x</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jog Fwd</td><td>x</td><td></td><td>x</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jog Rev</td><td>x</td><td></td><td>x</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fwd/Rev</td><td></td><td></td><td></td><td>x</td><td>x</td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

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Alarm	Type	Description
Dig In ConflictC	2	More than one physical input has been configured to the same input function. Multiple configurations are not allowed for the following input functions: Forward/Reverse, Run Reverse, Bus Regulation Mode B Speed Select 1, Jog Forward, Acc2 / Dec2 Speed Select 2, Jog Reverse, Accel 2 Speed Select 3, OIM Control, Decel 2 Run Forward, Stop Mode B, Run
Drive OL Level 1	1	The calculated IGBT temperature requires a reduction in PWM carrier frequency. If Drive OL Mode (150) is disabled and the load is not reduced, an overload fault will eventually occur.
Drive OL Level 2	1	The calculated IGBT temperature requires a reduction in Current Limit. If Drive OL Mode (150) is disabled and the load is not reduced, an overload fault will eventually occur.
Flux Amps Ref Rang	2	Result of autotune procedure (61).
IntDBRes OvrHeat	1	The drive has temporarily disabled the dynamic braking regulator because the resistor temperature has exceeded a predetermined value.
IR Volts Range	2	The drive autotuning default is Calculate and the value calculated for IR Drop Volts is not in the range of acceptable values. This alarm should clear when all motor nameplate data is properly entered.
MaxFreq Conflict	2	The sum of Maximum Speed (82) and Overspeed Limit (83) exceeds Maximum Freq (55). Raise Maximum Freq (55) or lower Maximum Speed (82) and/or Overspeed Limit (83) so that the sum is less than or equal to Maximum Freq (55).
Motor Type Cflct	2	Motor Type (90) has been set to Sync Prm Mag or Sync Reluc, and one or more DC functions (for example, DC Boost, DC Brake, etc.) have been activated. DC injection functions are incompatible with synchronous motors and may demagnetize them.
NP Hz Conflict	2	Fan/pump mode is selected in Torq Perf Mode (53), and the ratio of Motor NP Hertz (43) to Maximum Freq (55) is greater than 26.
Power Loss	1	Drive has sensed a power line loss.
Prechrg Actv	1	Drive is in the initial DC bus precharge state.
Speed Ref Cflct	2	Speed Ref x Sel or PI Reference Sel is set to “Reserved”.
Under-Voltage	1	The bus voltage has dropped below a predetermined value.
VHz Neg Slope	2	Custom V/Hz mode has been selected in Torq Perf Mode (53) and the V/Hz slope is negative.

About Faults

Faults indicate conditions within the drive that require immediate attention. The drive responds to a fault by initiating a coast-to-stop sequence and turning off power to the motor.

A flashing red LED indicates a fault has occurred and a fault signal will appear in the chiller touchscreen. A steady red LED indicates that it is non-resettable.

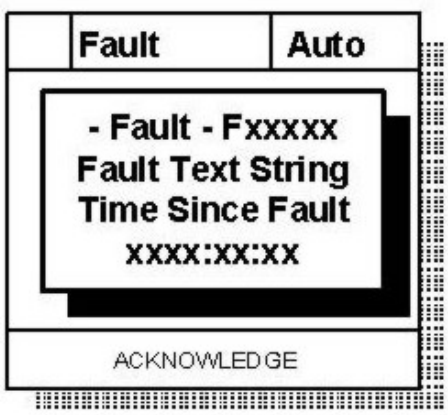
Table 23, Fault Types

Type	Fault Description	
1	Auto-Reset/Run (Not used on McQuay units)	If the drive is running when this type of fault occurs, and Auto Rstrt Tries (174) is set to a value greater than 0, a user-configurable timer, Auto Rstrt Delay (175) begins. When the timer reaches zero, the drive attempts to automatically reset the fault. If the condition that caused the fault is no longer present, the fault will be reset and the drive will be restarted.
2	Non-Resettable	This type of fault normally requires drive or motor repair. The cause of the fault must be corrected before the fault can be cleared. The fault will be reset on power up after repair.
3	User-Configurable	These faults can be enabled/disabled to either annunciate or ignore a fault condition using Fault Config 1 (238).

The drive indicates faults in the following ways:

- Ready LED on the drive cover (see section 12.3).
- Drive status parameters Drive Status 1 (209) and Drive Status 2 (210).
- Entries in the fault queue (see section 12.5.1).
- Pop-up screen on the LCD OIM. See figure 12.4. The screen displays:
    - Fault number
    - Fault name
    - Time that has elapsed since fault occurred.

Figure 34, Sample Fault Screen on the LCD OIM



NOTES:

1. Press any F Key to acknowledge the fault
2. The fault screen is displayed until it is acknowledged by pressing any F-key or cleared in the drive by other means.

About the Fault Queue

The drive automatically retains a history of faults that have occurred in the fault queue. The fault queue is accessed using the OIM or VS Utilities software.

The fault queue holds the eight most recent faults. The last fault to occur is indicated in queue entry #1. As new faults are logged into the queue, existing fault entries are shifted (for example, entry #1 will move to entry #2). Once the queue is full, older faults are discarded from the queue as new faults occur.

All entries in the fault queue are retained if power is lost.

The Time Stamp

For each entry in the fault queue, the system also displays a fault code and time stamp value. The time stamp value is the value of an internal drive-under-power timer at the time of the fault. The value of this timer is copied to PowerUp Marker (242) when the drive powers up. The fault queue time stamp can then be compared to the value in PowerUp Marker to determine when the fault occurred relative to the last drive power up.

The time stamp is cleared when the fault queue is cleared.

Clearing Faults

A fault condition can be cleared by the following:

Step 1. Press the ESC/Prog key or any F-Key to acknowledge the fault and remove the fault pop-up from the LCD OIM screen.

Step 2. Address the condition that caused the fault. The cause must be corrected before the fault can be cleared.

Step 3. After corrective action has been taken, clear the fault using one of the following:

- Setting Fault Clear (240) to Clear Faults (1).
- Press F1 (Cflt) from the fault queue screen.
- Issuing a Stop-Clear Faults command from the control source.

Resetting faults will clear the faulted status indication. If any fault condition still exists, the fault will be latched, and another entry made in the fault queue.

Note that performing a fault reset does not clear the fault queue. Clearing the fault queue is a separate action. See the Fault Clear (240) parameter description.

The table beginning on the following page, describes drive faults and corrective actions. It also indicates the fault type as:

1 Auto-resettable 2 Non-resettable 3 User-configurable

Table 24, SP600 Fault Descriptions and Corrective Actions

Fault	No.	Type	Description	Action
Analog In Loss	29	1,2	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with Anlg In 1, 2 Loss (324, 327).	1. Check parameters. 2. Check for broken/loose connections at inputs.
Anlg Cal Chksum	108	2	The checksum read from the analog calibration data does not match the checksum calculated.	Replace drive.
Auto Rstrt Tries	33	3	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of Auto Rstrt Tries (174). Enable/disable with Fault Config 1 (238).	Correct the cause of the fault and manually clear.
AutoTune Aborted	80		The autotune procedure was canceled by the user.	Restart procedure.
DB Resistance	69		Resistance of the internal DB resistor is out of range.	Replace resistor.
Decel Inhibit	24	3	The drive is not following a commanded deceleration because it is attempting to limit bus voltage.	1. Verify input voltage is within drive specified limits. 2. Verify system ground impedance follows proper grounding techniques. 3. Disable bus regulation and/or add dynamic brake resistor and/or extend deceleration time.
Drive OverLoad	64		Drive rating of 110% for 1 minute or 150% for 3 seconds has been exceeded.	Reduce load or extend Accel Time (140).
Excessive Load	79		Motor did not come up to speed in the allotted time.	1. Uncouple load from motor. 2. Repeat Autotune (61).
FluxAmpsRef Rang	78		The value for flux amps determined by the autotune procedure exceeds the programmed Motor NP FLA (42).	1. Reprogram Motor NP FLA (42) with the correct motor nameplate value. 2. Repeat Autotune (61).

Continued next page.

Fault	No.	Type	Description	Action

Function Loss	2	1	Function loss input is open.	Check remote wiring.
Ground Fault	13	1	A current path to earth ground greater than 25% of drive rating.	Check the motor and external wiring to the drive output terminals for a grounded condition.
Heatsink OvrTemp	8	1	Heatsink temperature exceeds a predefined value of 90°C (195°F).	1. Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40°C (104°F) NEMA Type 1 installations or 50°C (122°F) for Open type installations. 2. Check fan.
HW Over Current	12	1	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current. Motor dynamics cannot be accommodated by autotuning. Manual tuning of the current loop required. Consult technical support.
Incompat MCB-PB	106	2	Drive rating information stored on the power board is incompatible with the Main Control board.	Load compatible version files into drive.
I/O Comm Loss	121	2	Loss of communication to I/O board.	Cycle power.
I/O Board Fail	122		Board failure.	1. Cycle power. 2. If fault repeats, replace I/O board
I/O Mismatch	120		Incorrect I/O board identified.	Restore I/O board to original configuration, or If new configuration is desired, reset fault.
IR Volts Range	77		The drive autotuning default is Calculate and the value calculated for IR Drop Volts is not in the range of acceptable values.	Re-enter motor nameplate data.
Motor Overload	7	1, 3	Internal electronic overload trip. Enable/disable with Fault Config 1 (238).	An excessive motor load exists. Reduce load so drive output current does not exceed the current set by Motor NP FLA (42).
Over Speed Limit	25	1	Functions such as slip compensation or bus regulation have attempted to add an output frequency adjustment greater than that programmed in Overspeed Limit (83).	Remove excessive load or overhauling conditions or increase Overspeed Limit (83).
Over Voltage	5	1	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the □ecal time or install dynamic brake option.
Parameter Chksum	100	2	The checksum read from the board does not match the checksum calculated.	1. Restore defaults. 2. Reload user set if used.

Continued next page.

Fault	No.	Type	Description	Action
Params Defaulted	48		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
Phase Imbalance	37		Phase current displayed in Imbalance Display (221) > percentage set in Imbalance Limit (49) for time set in Imbalance Time (50).	Clear fault.
Phase U to Grnd	38		A phase-to-ground fault has been detected between the drive and motor in this phase.	1. Check the wiring between the drive and motor. 2. Check motor for grounded phase. 3. Replace drive.
Phase V to Grnd	39			
Phase W to Grnd	40			
Phase UV Short	41		Excessive current has been detected between these two output terminals.	1. Check the motor and drive output terminal wiring for a shorted condition. 2. Replace drive.
Phase VW Short	42			
Phase UW Short	43			
Port 1-6 DPI Loss	8186		DPI port stopped communicating. An attached peripheral with control capabilities via Logic Source Sel (89) (or OIM control) was removed. The fault code indicates the offending port number (81 = port 1, etc.)	1. If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters, Main Control board or complete drive as required. 2. Check OIM connection.
Port 1-6 Net Loss	7176		The network card connected to DPI port stopped communicating. The fault code indicates the offending port number (71 = port 1, etc.)	1. Check communication adapter board for proper connection to external network. 2. Check external wiring to adapter on port. 3. Verify external network fault.
Power Loss	3	1, 3	DC bus voltage remained below 85% of nominal for longer than Power Loss Time (185). Enable/disable with Fault Config 1 (238).	Monitor the incoming AC line for low voltage or line power interruption.
Power Unit	70		One or more of the output transistors were operating in the active region instead of desaturation. This can be caused by excessive transistor current or insufficient base drive voltage.	1. Check for damaged output transistors. 2. Replace drive.
Pwr Brd Chksum1	104		The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.	Clear the fault or cycle power to the drive.
Pwr Brd Chksum2	105	2	The checksum read from the board does not match the checksum calculated.	1. Cycle power to the drive. 2. If problem persists, replace drive.
Replaced MCB-PB	107	2	Main Control board was replaced and parameters were not programmed.	1. Restore defaults. 2. Reprogram parameters.
Shear Pin	63	3	Programmed Current Lmt Val (148) has been exceeded. Enabled/disable with Fault Config 1 (238).	Check load requirements and Current Lmt Val (148) setting.

Fault	No.	Type	Description	Action
SW Over Current	36	1	The drive output current has exceeded the software current.	Check for excess load, improper DC boost setting. DC brake volts set too high.
Trnsistr OvrTemp	9	1	Output transistors have exceeded their maximum operating temperature.	1. Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40°C (104°F) for NEMA Type 1 installations or 50°C (122°F) for Open type installations. 2. Check fan.
Under Voltage	4	1, 3	DC bus voltage fell below the minimum value of 160V DC at 200/240V input, 300V DC at 400/480V input or 375V DC at 575V input. Enable/disable with Fault Config 1(233).	Monitor the incoming AC line for low voltage or power interruption.
UserSet1 Chksum	101	2	The checksum read from the user set does not match the checksum calculated.	Re-save user set.
UserSet2 Chksum	102	2		
UserSet3 Chksum	103	2		

Table 25, LF 2.0 Fault Descriptions and Corrective Actions

Fault	No.	Type	Description	Action
AC Line Lost	227		Input power Lost	1. Verify proper input voltage. 2. Check line sync board and fuse. 3. Check AC line I/O board. 4. 4. Verify connection between boards.
Analog In Loss	29	1 3	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with Anlg In 1, 2 Loss (324, 327).	1. Check parameters. 2. 2. Check for broken/loose connections at inputs.
Auto Rstrt Tries	33	1	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of Auto Rstrt Tries (174). Enable/disable with Fault Config 1 (238).	Correct the cause of the fault and manually clear.
AutoTune Aborted	80		The autotune procedure was canceled by the user.	Restart procedure.
Auxiliary Input	2	1	Input is open.	Check remote wiring.
Decel Inhibit	24	3	The drive is not following a commanded deceleration because it is attempting to limit bus voltage.	1. Verify input voltage is within drive specified limits. 2. Verify system ground impedance follows proper grounding techniques. 3. Disable bus regulation and/or add dynamic brake resistor and/or extend deceleration time.
Drive OverLoad	64		Drive rating of 110% for 1 minute or 150% for 3 seconds has been exceeded.	Reduce load or extend Accel Time (140).
Excessive Load	79		Motor did not come up to speed in the allotted time.	1. Uncouple load from motor. 2. Repeat Autotune (61).

Continued next page.

Fault	No.	Type	Description	Action
FluxAmpsRef Rang	78		The value for flux amps determined by the autotune procedure exceeds the programmed Motor NP FLA (42).	1. Reprogram Motor NP FLA (42) with the correct motor nameplate value. 2. Repeat Autotune (61).
Ground Fault	13	1	A current path to earth ground in excess of 7% of drive rated amps has been detected at one or more of the drive output terminals.	Check the motor and external wiring to the drive output terminals for a grounded condition.
High AC Line	222		Input line voltage is too high.	Reduce input voltage to meet specification of 480 ±10%.
HW OverCurrent	12	1	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current.
I/O Board Comm Loss	121	2	Loss of communication to I/O board.	Cycle power.
I/O Board Fail	122		Board failure.	1. Cycle power. 2. If fault repeats, replace I/O board
I/O Board Mismatch	120		Incorrect I/O board identified.	Restore I/O board to original configuration, or If new configuration is desired, reset fault.
Incompat MCB-PB	106	2	Drive rating information stored on the power board is incompatible with the Main Control board.	Load compatible version files into drive.
Input Amp Imbalance	225		Input phase current imbalance exceeded limits.	Check for loose connection in input power wiring.
Input Volt Imbalance	226		Input voltage imbalance exceeded limits.	Check for problem in input power distribution.
Inverter Dsat U, V, W	200 201 202		High current was detected in an IGBT.	1. Check for loose connection in IGBT wire harness. 2. Check IGBTs.
Inverter OverCurrent U, V, W	203 204 205		High current was detected in an IGBT.	1. Verify proper motor data is entered. 2. Reduce current limit.
Invtr Base Temp	8	1	Base temperature exceeded limit.	Check for proper temperature and flow rate of coolant.
Invtr Gate Kill	207		Inverter gate kill contact is open.	Close gate kill contact.
Invtr IGBT Temp	9	1	Output transistors have exceeded their maximum operating temperature.	Check for proper temperature and flow rate of coolant.
IR Volts Range	77		The drive autotuning default is Calculate, and the value calculated for IR Drop Volts is not in the range of acceptable values.	Re-enter motor nameplate data.
Line Frequency	228		Line frequency not in the range of 47-63 Hz.	Verify connection between AC Line Sync and AC Line I/O boards.
Low DC Bus	223		The bus voltage is too low.	Verify proper input voltage.
Motor I Imbalance	37		Phase current displayed in Imbalance Display (221) > percentage set in Imbalance Limit (49) for time set in Imbalance Time (50).	Clear fault.
Motor Overload	7	1 3	Internal electronic overload trip. Enable/disable with Fault Config 1 (238).	An excessive motor load exists. Reduce load so drive output current does not exceed the current set by Motor NP FLA (42).

OverSpeed Limit	25	1	Functions such as slip compensation or bus regulation have attempted to add an output frequency adjustment greater than that programmed in Overspeed Limit (83).	Remove excessive load or overhauling conditions or increase Overspeed Limit (83).
OverVoltage	5	1	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decal time or install dynamic brake option.
Parameter Chksum	100	2	The checksum read from the board does not match the checksum calculated.	1. Restore defaults. 2. Reload user set if used.
Params Defaulted	48		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
Phase U to Grnd	38		A phase-to-ground fault has been detected between the drive and motor in this phase.	1. Check the wiring between the drive and motor. 2. Check motor for grounded phase. 3. Replace drive.
Ph V To Grnd	39			
Phase W to Grnd	40			
Phase UV Short	41		Excessive current has been detected between these two output terminals.	1. Check the motor and drive output terminal wiring for a shorted condition. 2. Replace drive.
Phase VW Short	42			
Phase UW Short	43			
Port 1-5 DPI Loss	81 85		DPI port stopped communicating. An attached peripheral with control capabilities via Logic Source Sel (89) (or OIM control) was removed. The fault code indicates the offending port number (81 = port 1, etc.)	1. If module was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, modules, Main Control board or complete drive as required. 2. Check OIM connection.
Port 1-5 Net Loss	71 75		The network card connected to DPI port stopped communicating. The fault code indicates the offending port number (71 = port 1, etc.)	1. Check communication board for proper connection to external network. 2. Check external wiring to module on port. 3. Verify external network fault.
Power Loss	3	1 3	DC bus voltage remained below 85% of nominal for longer than Power Loss Time (185). Enable/disable with Fault Config 1 (238).	Monitor the incoming AC line for low voltage or line power interruption.
Precharge closed	233		Precharge was closed when it should be open.	1. Check AUX contacts on precharge. 2. Check input bit 0 in rectifier parameter 216 to view status of input. 3. Check wiring.
Precharge open	234		Precharge was open when it should be closed.	1. Check AUX contacts on precharge. 2. Check input bit 0 in rectifier parameter 216 to view status of input. 3. Check wiring.

Pwr Brd Chksum1	104		The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.	Clear the fault or cycle power to the drive.
Pwr Brd Chksum2	105	2	The checksum read from the board does not match the checksum calculated.	1. Cycle power to the drive. 2. If problem persists, replace drive.
Rctfr I/O Board	236		Loss of communication to I/O board. Board failure.	Cycle power. 1. Cycle power. 2. 2. If fault repeats, replace I/O board
Rctfr Not OK	232		A fault was detected in the rectifier other than one specifically decoded.	Look at rectifier parameter 243 to see fault code.
Rctfr Over Volt	224		The bus voltage is too high.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
Rctfr Pwr Board	235		Drive rating information stored on the power board is incompatible with the Main Control board. The checksum read from the board does not match the checksum calculated.	Load compatible version files into drive. 1. Cycle power to the drive. 2. If problem persists, replace drive.
Rectifier Base Temp	217		Excessive rectifier temperature measured.	Check for proper temperature and flow rate of coolant.
Rectifier Dsat U, V, W	208 209 210		High current was detected in an IGBT.	1. Check for loose connection in IGBT wire harness. 2. Check IGBTs.
Rectifier Ground Fault	216		Excessive ground current measured.	Check for grounded input wiring.
Rectifier IGBT Temp	218		Excessive calculated IGBT temperature.	Check for proper temperature and flow rate of coolant.
Rectifier IOC U, V, W	211 212 213		Rectifier overcurrent	1. Verify proper motor data is entered. 2. Reduce current limit.
Rectifier Checksum	229		The checksum read from the board does not match the checksum calculated.	1. Restore defaults. 2. Reload user set if used.
Reactor Temp	214		Temperature switch in reactor opened.	Check for proper temperature and fan operation.
Rectifier IT Overload	219		Short-term current rating of rectifier exceeded.	Low input voltage can result in increased current load. Provide proper input voltage to the drive.
Rectifier I2T Overload	220		Long-term current rating of rectifier exceeded.	Low input voltage can result in increased current load. Provide proper input voltage to the drive.
Replaced MCB-PB	107	2	Main Control board was replaced and parameters were not programmed.	1. Restore defaults. 2. Reprogram parameters.
Ride Thru Abort	221		Input power loss timed out.	1. Verify input power and connections. 2. Check Line Sync board. 3. Check AC Line I/O board.

Continued next page.

Fault	No.	Type	Description	Action
Shear Pin	63	3	Programmed Current Lmt	Check load requirements and

			Val (148) has been exceeded. Enabled/disable with Fault Config 1 (238).	Current Lmt Val (148) setting.
SW OverCurrent	36	1	The drive output current has exceeded the software current.	Check for excess load, improper DC boost setting. DC brake volts set too high.
UnderVoltage	4	1 3	DC bus voltage fell below the minimum value of 407V DC at 400/480V input or 204V DC at 200/240V input. Enable/disable with Fault Config 1(233).	Monitor the incoming AC line for low voltage or power interruption.
UserSet1 Chksum	101	2	The checksum read from the user set does not match the checksum calculated.	Re-save user set.
Set2	102	2		
Set3	103	2		

Troubleshooting

Common Symptoms and Corrective Actions

Table 26, No Start From Terminal Block Logic

Indication(s)	Cause(s)	Corrective Action
Flashing red Ready LED.	Drive is faulted.	Clear fault: • Press OIM stop key if that OIM is control source. •Cycle power. • Set Fault Clear (240) to 1. • Toggle terminal block stop or terminal block reset digital input if terminal block is the control source.
Incorrect operation from the terminal block.	Incorrect input wiring. • 2-wire control requires Run, Run Forward, or Run Reverse input(s). • 3-wire control requires Start and Stop inputs • Jumper from terminal 7 to 8 is required.	Wire inputs correctly and/or install jumper.
	Incorrect digital input programming. • Mutually exclusive choices have been made. • 2-wire and 3-wire programming may be conflicting. • Exclusive functions (i.e, direction control) may have multiple inputs configured. • Stop if factory default and is not wired or is open. • Start or Run programming may be missing.	Program Digital In"x" Sel (361-366) for correct inputs.
	Logic Source Sel is not set to Terminal Blk.	Set Logic Source Sel to Terminal Blk.

Continued next page.

Table 27, No Start From Terminal Block Logic (Continued)

Indication(s)	Cause(s)	Corrective Action
Flashing yellow Ready LED and DigIn CflctB indication on LCD OIM. Drive Status 2. (210) shows type 2 alarm(s).	Incorrect digital input programming. • Mutually exclusive choices have been made. • 2-wire and 3-wire programming may be conflicting. • Exclusive functions (i.e, direction control) may have multiple inputs configured. • Stop if factory default and is not wired or is open. • Start or Run programming may be missing.	Program Digital In"x" Sel (361-366) to resolve conflicts. Remove multiple selections for the same function Install stop button to apply a signal at stop terminal.

Table 28, No Start From OIM

Indication	Cause(s)	Corrective Action
None	Drive is programmed for 2-wire control and Logic Source Sel (89) = All Ports. OIM start and network start are disabled for 2-wire control.	If 2-wire control is required, no action is necessary. If 3-wire control is required, program Digital Inx Sel (361-366) for correct inputs.
Flashing or steady red Ready LED.	Active fault.	Reset fault.
Flashing yellow Ready LED.	Enable input is open.	Close terminal block enable input.
	The terminal block stop input is open and control source is set to All Ports.	Close terminal block stop input.
	Start inhibit bits are set.	Check status in Start Inhibits (214).
Drive Status 1 (209) indicates logic control source.	Logic Source Sel (89) is not equal to the desired OIM (Local OIM, DPI Port 2, or DPI Port 3). DPI Port 2 is required for remote OIM.	Verify setting of Logic Source Sel (89). The OIM Control digital input effectively sets the control source to the lowest attached OIM port.

Table 29, No Response to Changes in Speed Command

Indication	Cause(s)	Corrective Action
LCD OIM Status Line indicates "At Speed" and output is 0 Hz.	No value is coming from the source of the command.	1. If the source is an analog input, check wiring and use a meter to check for presence of signal. 2. Check Commanded Freq (2) for correct source.
None	Incorrect reference source has been programmed.	1. Check Speed Ref Source (213) for the source of the speed reference. 2. Reprogram Speed Ref A Sel (90) for correct source.
None	Incorrect reference source is being selected via remote device or digital inputs.	1. Check Drive Status 1 (209), bits 12 - 15 for unexpected source selections. 2. Check Dig In Status (216) to see if inputs are selecting an alternate source. 3. Reprogram digital inputs to correct Speed Sel x option.
Speed reference from analog input	Improper reference common signal wiring.	1. Verify that common is properly connected to AnlgIn(-) terminal.

Table 30, Motor Will Not Accelerate to Commanded Speed

Indication	Cause(s)	Corrective Action
Acceleration time is excessive.	Incorrect value in Accel Time "x" (140, 141).	Reprogram Accel Time "x" (140, 141).
Drive is forced into current limit, slowing or stopping acceleration.	Excess load or short acceleration time.	Check Drive Status 2 (210), bit 10 to see if the drive is in current limit. Remove excess load or reprogram Accel Time "x" (140, 141).
Speed command source or value is not as expected.	Improper speed command.	Check for the proper speed command using steps 1 through 7 in table 12.11.
Programming is preventing the drive output from exceeding limiting values.	Incorrect programming.	Check Maximum Speed (82) and Maximum Freq (55) to insure that speed is not limited by programming.

Table 31, Motor Operation is Unstable

Indication	Cause(s)	Corrective Action
None	Motor data was incorrectly entered or autotune was not performed.	1. Correctly enter motor nameplate data. 2. Perform static or rotate autotune procedure (61).

Table 32, Stopping the Drive Results in a Decel Inhibit Fault

Indication	Cause(s)	Corrective Action
Decel Inhibit fault screen. LCD status line indicates Faulted.	The bus regulation feature is enabled and is halting deceleration due to excessive bus voltage. Excess bus voltage is normally due to excessive regenerated energy or unstable AC line input voltages. Internal timer has halted drive operation.	1. Reprogram bus regulation (parameters161 and 162) to eliminate any Adjust Freq selection. 2. Disable bus regulation (parameters 161 and162) and add a dynamic brake. 3. Correct AC input line instability or add an isolation transformer. 4. Reset drive

Troubleshooting the Drive w/ the LCD OIM

The LCD OIM provides immediate visual notification of alarm or fault conditions as well as the following diagnostic information:

- Entries in the fault queue
- Fault parameters
- Drive status parameters
- Selected device version and status information
- OIM version information

Accessing the Fault Queue

The drive automatically retains a history of the last eight faults that have occurred in the fault queue.

To access the fault queue, press the F4 key at the process display screen, or see Figure 35 to access the fault queue from the Main Menu.

Figure 35, Accessing the Fault Queue

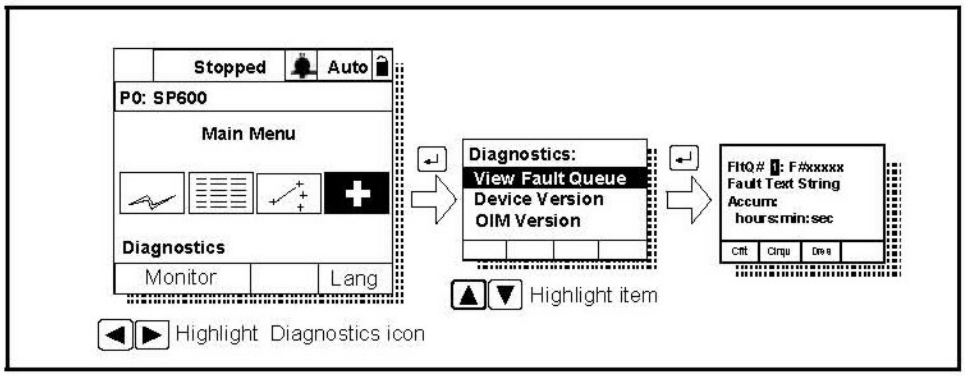
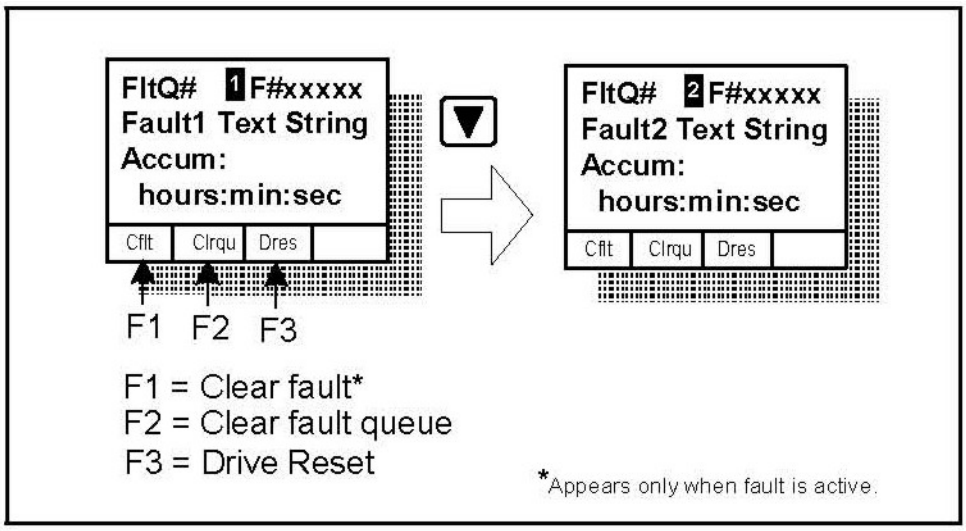


Figure 36, Sample Fault Queue Entry



The drive can be reset (as if the power were cycled) by pressing the F3 (Dres) function key while in the "View Fault Queue" screens. The reset function is active only while the drive is stopped. During a reset, drive communication with peripheral devices will stop until the reset function completes.

CAUTION:

Pressing F3 (Dres) will immediately cause the drive to be reset. This may result in communication errors in other devices attached to the drive which could result in machine damage.

The status of the drive can be viewed on the Human Interface Module (HIM) or on various LEDs.

Using the Interface

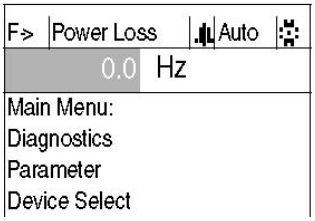
Figure 37, Human Interface Module (HIM)

The interface module can be removed to provide security against tampering with the control. To do so, first press the ALT key, release it and then press the left arrow (REMOVE) key, This procedure allows the module to be removed without causing a fault. Then press the tab on top of the module and slide the module upwards and out.

One function of the module is to program the various parameters that control the VFD/chiller operation. Programming is to be done only by service technicians who are factory trained and authorized to work on VFDs.

The module is used by the operator to troubleshoot the drive by viewing faults, and to clear faults after corrective action has been taken, as explained later in this section.

Figure 38, LCD Display, Main Menu

Display	Description
	Direction | Drive Status | Alarm | Auto/Man | Information Commanded or Output Frequency Programming / Monitoring / Troubleshooting

LEDs

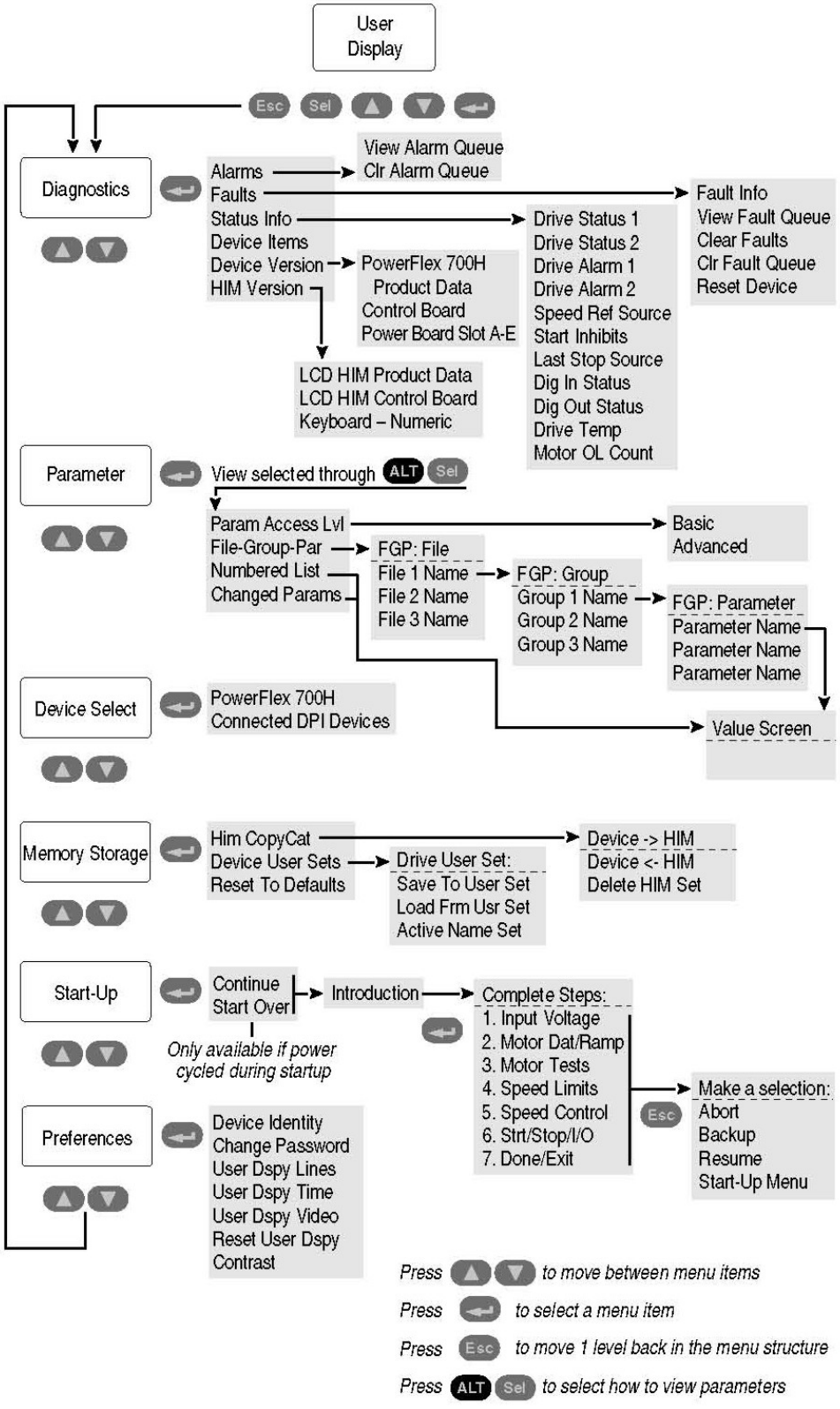
Illumination of a yellow LED indicates the presence of an alarm, a red LED indicated a fault.

Viewing Faults and Alarms

The primary area of interest to the operator is viewing drive alarms and faults. Alarms are problems that do not shut down the drive/compressor. They may eventually turn into faults, which do stop the compressor.

From the main menu, use the Up or Down arrows, ◀ or ▶ ,to select Diagnostics. See Figure 38. Press the Enter key, ↵ to select this menu. Then use these navigating keys to reach a desired menu as shown in Figure 39.

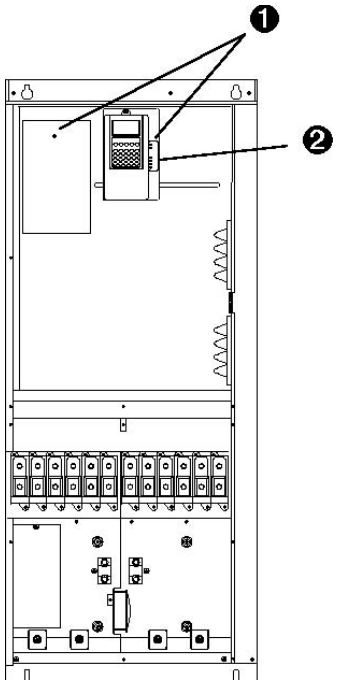
Figure 39, HIM Menu Structure



Using the LEDs

Drive LEDs

Figure 40, Front Panel LED Indications



#	Name	Color	State	Description
1	PWR (Power)	Green	Steady	Illuminates when power is applied to the drive.
2	PORT(1)	Green	–	Status of DPI port internal communications (if present).
	MOD(1)	Yellow	–	Status of communications module (when installed).
	NET A(1)	Red	–	Status of network (if connected).
	NET B(1)	Red	–	Status of secondary network (if connected).

This section provides information to guide you in troubleshooting the PF 700H control family. Included is a listing and description of drive faults (with possible solutions, when applicable) and alarms.

Faults and Alarms

A fault is a condition that stops the drive. There are three fault types:

Table 33, Fault Types

Type	Fault	Description
1	Auto-Reset Run	When this type of fault occurs, and [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, [Auto Rstrt Delay] begins. When the timer reaches zero, the drive attempts to automatically reset the fault. If the condition that caused the fault is no longer present, the fault will be reset and the drive will be restarted.
2	Non-Resettable	This type of fault normally requires drive or motor repair. The cause of the fault must be corrected before the fault can be cleared. The fault will be reset on power up after repair
3	User Configurable	These faults can be enabled/disabled to annunciate or ignore a fault condition.

An alarm is a condition that, if left untreated, may stop the drive. There are two alarm types:

Table 34, Alarm Types

Type	Alarm	Description
1	User Configurable	These alarms can be enabled or disabled through [Alarm Config 1]. It is recommended that factory setting not be changed.
2	Non-Configurable	These alarms are always enabled.

Drive Status

The condition or state of the drive is constantly monitored. Any changes will be indicated through the LEDs and/or the Human Interface module (HIM).

Clearing Alarms

Alarms clear automatically when the condition that caused the alarm is no longer present.

HIM Indication

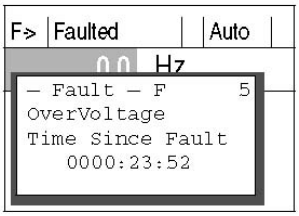
The LCD HIM also provides visual notification of a fault or alarm condition on the top line.

Drive is indicating a fault.

The LCD HIM immediately reports the fault condition by displaying the following.

- "Faulted" appears in the status line
- Fault number
- Fault name
- Time that has passed since fault occurred

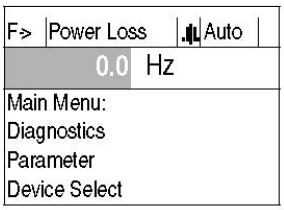
Press Esc to regain HIM control.



Drive is indicating an alarm.

The LCD HIM immediately reports the alarm condition by displaying the following.

- Alarm name (Type 2 alarms only)
- Alarm bell graphic



Manually Clearing Faults

1. Press Esc to acknowledge the fault. The fault information will be removed so that you can use the HIM.

2. Address the condition that caused the fault. The cause must be corrected before the fault can be cleared.
3. After corrective action has been taken, clear the fault by **one** of these methods.
   - Press Stop
   - Cycle drive power
   - Set parameter 240 [Fault Clear] to "1."
   - "Clear Faults" on the HIM Diagnostic menu.

Table 35, Fault/Alarm Types, Description and Actions

NOTE: See Table 33 and Table 34 for definition of fault/alarm types.

No.	Name	Fault	Alarm	Description	Action *(if appropriate)*
1	PrechargeActv		1	Drive received a start command while in the DC bus precharge state.	
2	Auxiliary In	1		Auxiliary input interlock is open.	Check remote wiring.
3	Power Loss	1, 3	1	DC bus voltage remained below [Power Loss Volts] for longer than [Power Loss Time]. Enable/Disable with [Fault Config 1]	Monitor the incoming AC line for low voltage or line power interruption.

Continued next page.

No.	Name	Fault	Alarm	Description	Action *(if appropriate)*
4	UnderVoltage	1, 3	1	DC bus voltage fell below the minimum value of 333V for 400/480V drives and 461V for 600/ 690V drives. Enable/ Disable with [Fault Config 1]	Monitor the incoming AC line for low voltage or power interruption.
5	OverVoltage	1		DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
6	Motor Stall	1		Motor is operating at high current and low frequency and is not accelerating.	1. Run Autotune 2. Reduce Load
7	MotorOverload	1, 3		Internal electronic overload trip. Enable/Disable with [Fault Config 1).	1. Run Autotune 2. Verify settings of [Motor Overload Factor] and [Motor Overload Frequency]. 3. Reduce load so drive output current does not exceed the current set by [Motor NP FLA].
8	HeatsinkOvrTp	2	1	Heatsink temperature exceeds maximum allowable value. 85 degrees C = Alarm 90 degrees C = Fault	1. Verify that maximum ambient temperature has not been exceeded. 2. Check fan. 3. Check for excess load. 4. Check carrier frequency
9	IGBT OverTemp	1		Output transistors have exceeded their maximum operating temperature due to excessive load.	1. Verify that maximum ambient temperature has not been exceeded. 2. Check fan. 3. Check for excess load.
10	System Fault	2		Hardware problem exists in the power structure.	1. Cycle power. 2. Replace drive.
12	OverCurrent	1		The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current. Check for shorted motor leads or shorted motor.
13	Ground Fault	1		A current path to earth ground greater than 25% of drive rating. Ground fault level is 50% of the drive's heavy duty current rating. The current must appear for 800ms before the drive will fault.	Check the motor and external wiring to the drive output terminals for a grounded condition.
14	InverterFault	2		Hardware problem in the power structure.	1. Cycle power. 2. Replace drive.
15	Load Loss	3	1		
16	Motor Therm	3	1	Option board thermistor input is greater than limit.	
17	Input Phase	3	1	One input line phase missing.	1. Check user-supplied fuses 2. Check AC input line voltage.
21	OutPhasMissng	2		Zero current in one output motor phase.	1. Check motor wiring. 2. Check motor for open phase.
22	NP Hz Cnflct		2	Fan/pump mode is selected in [Motor Cntl Sel] and the ratio of [Motor NP Hertz] to [Maximum Freq] is greater than 26.	
23	MaxFreqCnflct		2	The sum of [Maximum Speed] and [Overspeed Limit] exceeds [Maximum Freq]. Raise [Maximum Freq] or lower [Maximum Speed] and/or [Overspeed Limit] so that the sum is less than or equal to [Maximum Freq].	

Continued on next page.

No.	Name	Fault	Alarm	Description	Action *(if appropriate)*
24	Decel Inhibit	3	1	Drive cannot follow commanded decel due to bus limiting.	1. Verify that input voltage is within specified limits. 2. Verify that system ground impedance follows proper grounding techniques. 3. Disable bus regulation and/or add dynamic brake resistor and/or extend deceleration time.
25	OverSpd Limit	1		Functions such as Slip Compensation or Bus Regulation have attempted to add an output frequency adjustment greater than that programmed in [Overspeed Limit].	Remove excessive load or overhauling conditions or increase [Overspeed Limit].
26	VHz Neg Slope		2	[Motor Cntl Sel] = “Custom V/Hz” & the V/Hz slope is negative.	
27	SpdRef Cnflct		2	[Speed Ref x Sel] or [PI Reference Sel] is set to “Reserved”.	
28	BrakResMissing	2		No brake resistor detected.	1. Program [Bus Reg Mode x] to not use brake. 2. Install brake resistor.
29	Anlg In Loss	1, 3	1	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with [Anlg In 1, 2 Loss]	1. Check parameters. 2. Check for broken/loose connections at inputs.
30	MicroWatchdog	2	1	Microprocessor watchdog timeout.	1. Cycle Power. 2. Replace control.
32	Fan Cooling	3		Fan is not energized at start command.	
33	AutoReset Lim	2		Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of [Flt RstRun Tries]. Enable/Disable with [Fault Config 1]	Correct the cause of the fault and manually clear.
34	CAN Bus Flt	1		Sent message not acknowledged.	1. Cycle Power. 2. Replace control.
37	HeatsinkUndTp	1		Ambient temperature is too low.	Raise ambient temperature.
44	Device Change	2		New power unit or option board installed of different type.	Clear fault and reset drive to factory defaults.
45	Device Add	2		New option board added.	Clear fault.
47	NvsReadChksum	2		Error reading [Elapsed MWh] and [Elapsed Run Time] from EEPROM.	
48	ParamsDefault	2		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
50	MotorCalcData	2		Incorrect motor nameplate data.	Check motor nameplate data.
54	Zero Divide	2		This event called from arithmetical functions if divider is zero.	1. Cycle Power. 2. Replace control.

Continued on next page.

No.	Name	Fault	Alarm	Description	Action *(if appropriate)*
63	Shear Pin	3		Programmed [Current Lmt Val] has been exceeded. Enable/Disable with [Fault Config 1]	Check load requirements and [Current Lmt Val] setting.
65	I/O Removed	2		Option board removed.	
70	Power Unit	2		One or more of the output transistors were operating in the active region instead of desaturation. This can be caused by excessive transistor current or insufficient base drive voltage.	1. Clear fault.
71	Periph Loss	2		The communications card has a fault on the network side.	1. Check DPI device event queue and corresponding fault information for the device.
81	Port DPI Loss	2		DPI port stopped communicating. A SCANport device was connected to a drive operating DPI devices at 500k baud.	1. If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters, Main Control Board or complete drive as required. 2. Check HIM connection. 3. If an adapter was intentionally disconnected and the [Logic Mask] bit for that adapter is set to “1”, this fault will occur. To disable this fault, set the [Logic Mask] bit for the adapter to “0.”
94	Hardware Enbl			Enable signal missing from control terminal block.	1. Check control wiring. 2. Check position of hardware enable jumper. 3. Check digital input programming.
95	AutoT Rs Stat	2		Autotune Rs Static Test failed.	1. Verify that motor is not rotating when autotune is enabled. 2. Check motor connections.
96	AutoT Lm Rot	2		Autotune Lm rotate test failed.	1. Check motor nameplate data. 2. Check motor connections. 3. Verify that Accel Time < (Base Speed/40) x 33 sec. Note: 33 sec. = time limit to bring motor to 40 Hz.
97	AutoT MagRot	2		Autotune magnetizing current rotate test failed.	1. Check motor nameplate data. 2. Check motor connections. 3. Verify that Accel Time < (Base Speed/40) x 33 sec. (see above).
98	AutoT Saturat	2		Autotune saturation curve test failed.	1. Check motor nameplate data. 2. Check motor connections.
99	UserSet Timer	2		User Set load or save not completed in less than 5 sec.	Replace main control.
100	Param Chksum	2		The checksum read from the board does not match the checksum calculated.	1. Restore defaults. 2. Cycle power. 3. Reload User Set if used.
104	PwrBrd Chksum	2		The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.	1. Cycle power. 2. Replace drive.

Continued next page.

No.	Name	Fault	Alarm	Description	Action *(if appropriate)*
106	MCB-PB Config	2		Drive rating information stored on the power board is incompatible with the main control board.	1. Reset fault or cycle power. 2. Replace control board.
107	New IO Option	2		New option board added to control.	1. Restore defaults. 2. Reprogram parameters.
113	Fatal App	2		Fatal Application error.	1. Replace control board.
114	AutoT Enable	2		Autotune enabled but not started.	Press the Start key within 20 seconds of enabing autotune
120	I/O Change	2		Option board replaced.	Reset Fault.
121	I/O Comm Loss	2		.I/O Board lost communications with the Main Control Board.	Check connector. Check for induced noise. Replace I/O board or Main Control Board.

133 DigIn CnflctA — Fault: 2

Digital input functions are in conflict. Combinations marked with a "X" will cause an alarm. * Jog 1 and Jog 2

	Acc2/ Dec2	Acc2	Dece2	Jog*	Jog Fwd	Jog Rev	Fwd/ Rev
Acc2/ Dec2		X	X				
Acc2	X						
Dece2	X						
Jog*					X	X	
Jog Fwd				X			X
Jog Rev				X			X
Fwd/ Rev					X	X	

134 DigIn CnflctB — Fault: 2

.A digital Start input has been configured without a Stop input or other functions are in conflict. combinations that conflict are marked with a "**X** " and will cause an alarm. * Jog1 and Jog 2

	Start	Stop -CF	Run	Run Fwd	Run Rev	Jog*	Jog Fwd	Jog Rev	Fwd/ Rev
Start			X	X	X		X	X	
Stop -CF									
Run	X			X	X		X	X	
Run Fwd	X		X			X			X
Run Rev	X		X			X			X
Jog*				X	X				
Jog Fwd	X		X						
Jog Rev	X		X						
Fwd/ Rev				X	X				

135 DigIn CnflctC — Fault: 2

More than one physical input has been configured to the same input function. Multiple configurations are not allowed for the following inputs

Forward/Reverse	Run Reverse	Bus Regulation Mode B
Speed Select 1	Jog Forward	Acc2 / Dec2
Speed Select 2	Jog Reverse	Accel 2
Speed Select 3	Run	Decel 2
Run Forward	Stop Mode B	

Continued on next page.

No.	Name	Fault	Alarm	Description	Action *(if appropriate)*
136	BipolarCnflct .		2	Parameter 190 [Direction Mode] is set to “Bipolar” or “Reverse Dis” and one or more of the following digital input functions is configured: “Fwd/Reverse,” “Run Forward,” “Run Reverse,” “Jog Forward” or “Jog Reverse.”	
143	TB Man Conflict		2	[TB Man Ref Sel] is using an analog input that is programmed for another function.	Check parameter settings to avoid problem.
147	Start AtPwrUp		1	[Start At PowerUp] is enabled. Drive may start at any time within 10 seconds of drive powerup.	
148	IntDB OvrHeat		1	The drive has temporarily disabled the DB regulator because the resistor temperature has exceeded a predetermined value.	
149	Waking		1	The Wake timer is counting toward a value that will start the drive.	
150	Sleep Config		2	Sleep/Wake configuration error. With [Sleep-Wake Mode] = “Direct,” possible causes include: drive is stopped and [Wake Level] < [Sleep Level].“Stop=CF,” “Run,” “Run Forward,” or “Run Reverse.” is not configured in [Digital Inx Sel].	

Table 36, Fault/Alarm Cross Reference

Name	No.	Fault	Alarm	Name	No.	Fault	Alarm
Anlg In Loss	29	X	X	MCB-PB Config	106	X	
AutoReset Lim	33	X		MicroWatchdog	30	X	
AutoT Enable	114	X		Motor Stall	6	X	
AutoT Lm Rot	96	X		Motor Therm	16	X	X
AutoT MagRot	97	X		MotorCalcData	50	X	
AutoT Rs Stat	95	X		MotorOverload	7	X	
AutoT Saturat	98	X		New IO Option	107	X	
Auxiliary In	2	X		NP Hz Cnflct	22		X
BipolarCnflct	136		X	NvsReadChksum	47	X	
BrakResMissng	28	X		OutPhasMissng	21	X	
CAN Bus Flt	34	X		OverCurrent	12	X	
Decel Inhibit	24	X		OverSpd Limit	25	X	
Device Add	45	X		OverVoltage	5	X	
Device Change	44	X		Param Chksum	100	X	
DigIn CnflctA	133		X	ParamsDefault	48	X	
DigIn CnflctB	134		X	Periph Loss	71	X	
DigIn CnflctC	135		X	Port DPI Loss	81	X	
Fan Cooling	32	X		Power Loss	3	X	
Fatal App	113	X		Power Unit	70	X	
Ground Fault	13			PrechargeActv	1		X
Hardware Enbl	94	X		PwrBrd Chksum	104	X	
HeatsinkOvrTp	8	X		Shear Pin	63	X	
HeatsinkUndTp	37	X		Sleep Config	150		X
I/O Change	120	X		SpdRef Cnflct	27		X
I/O Comm Loss	121	X		Start AtPwrUp	147		X
I/O Removed	65	X		System Fault	10	X	
IGBT OverTemp	9	X		TB Man Conflict	143		X
Input Phase	17	X	X	UnderVoltage	4	X	X
IntDB OvrHeat	148		X	UserSet Timer	99	X	
InverterFault	14	X		VHz Neg Slope	26		X
Load Loss	15	X	X	Waking	149		X
MaxFreqCnflct	23		X	Zero Divide	54	X	

Troubleshooting

Table 37, No Start

Drive does not Start from Start or Run Inputs wired to the terminal block.		
Cause(s)	**Indication**	**Corrective Action**
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set [Fault Clear] to 1 • "Clear Faults" on the HIM Diagnostic menu.
Incorrect input wiring. See Installation Manual for wiring examples. • 2 wire control requires Run, Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs. • Jumper from terminal 25 to 26 is required.	None	Wire inputs correctly and/or install jumper.
Incorrect digital input programming. • Mutually exclusive choices have been made (i.e., Jog and Jog Forward). • 2 wire and 3 wire programming may be conflicting. • Exclusive functions (i.e, direction control) may have multiple inputs configured. • Stop is factory default and is not wired.	None	Program [Digital Inx Sel] for correct inputsStart or Run programming may be missing.
	Flashing yellow status light and "DigIn CflctB" indication on LCD HIM. [Drive Status 2] shows type 2 alarm(s).	Program [Digital Inx Sel] to resolve conflicts Remove multiple selections for the same function. Install stop button to apply a signal at stop terminal.

Table 38, No Start from HIM

Drive does not Start from HIM.		
Cause(s)	**Indication**	**Corrective Action**
Drive is programmed for 2 wire control. HIM Start button is disabled for 2 wire control.	None	If 2 wire control is required, no action needed. If 3 wire control is required, program [Digital Inx Sel] for correct inputs

Table 39, No Speed Change

Drive does not respond to changes in speed command.		
Cause(s)	**Indication**	**Corrective Action**
No value is coming from the source of the command.	LCD HIM Status Line indicates "At Speed" and output is 0 Hz.	1. If the source is an analog input, check wiring and use a meter to check for presence of signal. 2. Check [Commanded Speed] for correct source
Incorrect reference source has been programmed.	None	3. Check [Speed Ref Source] for the source of the speed reference. 4. Reprogram [Speed Ref A Sel] for correct source.
Incorrect Reference source is being selected via remote device or digital inputs.	None	5. Check [Drive Status 1], bits 12 and 13 for unexpected source selections. 6. Check [Dig In Statusto see if inputs are selecting an alternate source. 7. 7. Reprogram digital inputs to correct "Speed Sel x" option.

Table 40, No Acceleration

Motor and/or drive will not accelerate to commanded speed		
Cause(s)	**Indication**	**Corrective Action**
Acceleration time is excessive.	None	Reprogram [Accel Time x].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	Check [Drive Status 2], bit 10 to see if the drive is in Current Limit. Remove excess load or reprogram [Accel Time x].
Speed command source or value is not as expected.	None	Check for the proper Speed Command using Steps 1 through 7 above.
Programming is preventing the drive output from exceeding limiting values.	None	Check [Maximum Speed and [Maximum Freq] to assure that speed is not limited by programming.

Table 41, Unstable Operation

Motor operation is unstable.		
Cause(s)	**Indication**	**Corrective Action**
Motor data was incorrectly entered or Autotune was not performed.	None	1. Correctly enter motor nameplate data. 2. Perform “Static” or “Rotate” Autotune procedure 3. Set gain parameters to default values.

Table 42, Stopping Gives Decel Fault

Stopping the drive results in a Decel Inhibit fault.		
Cause(s)	Indication	Corrective Action
The bus regulation feature is enabled and is halting deceleration due to excessive bus voltage. Excess bus voltage is normally due to excessive regenerated energy or unstable AC line input voltages. Internal timer has halted drive operation	Decel Inhibit fault screen LCD Status Line indicates “Faulted”.	1. See Attention statement 2. Reprogram parameters 161/162 to eliminate any “Adjust Freq” selection. 3.Disable bus regulation (parameters 161 &162) and add a dynamic brake 4. Correct AC input line instability or add an isolation transformer. 5. Reset drive.

Diagnostics Menu

When a fault trips the drive, use this menu to access detailed data about the drive.

Table 43, Fault menu

Option	Description
Faults	View fault queue or fault information, clear faults or reset drive.
Status Info	View parameters that display status information about the drive.
Device Version	View the firmware version and hardware series of components.
HIM Version	View the firmware version and hardware series of the HIM.

Parameter Menu

Refer to Viewing and Editing Parameters

Device Select Menu

Use this menu to access parameters in connected peripheral devices.

Memory Storage Menu

Drive data can be saved to, or recalled from, User and HIM sets. User sets are files stored in permanent nonvolatile drive memory. HIM sets are files stored in permanent nonvolatile HIM memory.

Table 44, Memory Storage

Option	Description
HIM Copycat Device -> HIM Device <- HIM	Save data to a HIM set, load data from a HIM set to active drive memory or delete a HIM set
Device User Sets	Save data to a User set, load data from a User set to active drive memory or name a User set.
Reset To Defaults	Restore the drive to its factory-default settings

Preferences Menu

The HIM and drive have features that you can customize.

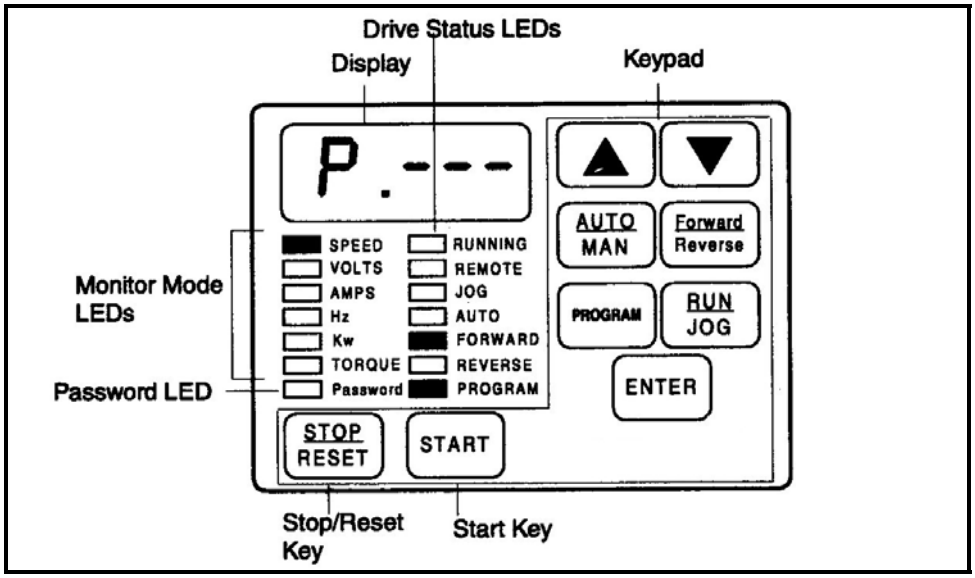
Option	Description
Drive Identity	Add text to identify the drive.
Change Password	Enable/disable or modify the password.
User Dspy Lines	Select the display, parameter, scale and text for the User Display. The User Display is two lines of user-defined data that appears when the HIM is not being used for programming.
User Dspy Time	Set the wait time for the User Display or enable/disable it.
User Dspy Video	Select Reverse or Normal video for the Frequency and User Display lines
Reset User Dspy	Return all the options for the User Display to factory default values.

.

The status of the drive can be viewed on the Operator Interface Module (OIM) or on various LEDs.

Using the Interface

Figure 41, Keypad/Display



The front-panel keypad/display is used to monitor the drive. The functions available at the keypad depend on what mode the keypad/display is in and what is selected as the drive control source. It operates in two modes:

1. Monitor Mode (the default mode), used to monitor specific drive outputs as well as enter the speed or frequency reference for the drive.
2. Program Mode, used to view and adjust drive parameter values, and examine the error log.

Regardless of the control source selection, the keypad/display can be used to stop the drive and reset drive faults.

See Table 46 for a description of the Drive status LEDs.

Note: The STOP/RESET key can be disabled by parameter R055. This must be done so that only the chiller MicroTech II controller can stop or start the drive/compressor.

Monitor Mode

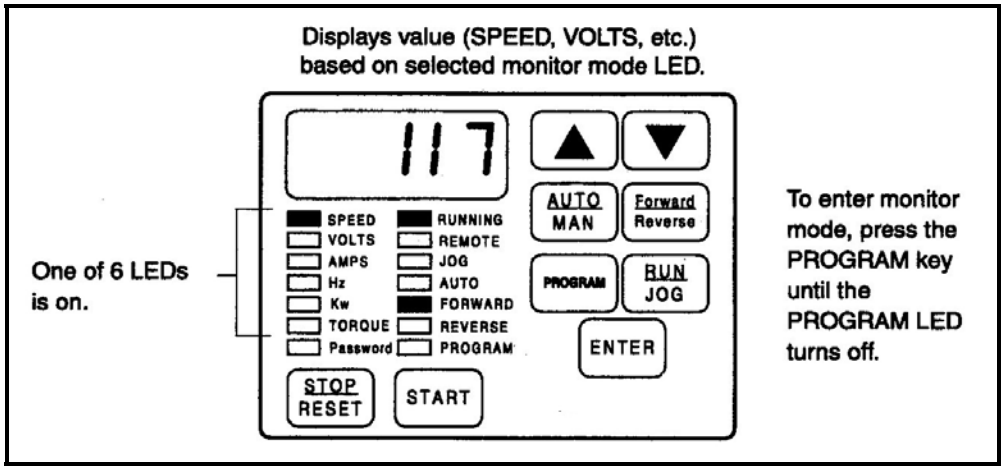
Monitor mode is the keypad/display's default mode during drive operation, or it is entered by pressing the PROGRAM key until the PROGRAM LED turns off. The following output data can be displayed in monitor mode:

- Speed
- Volts
- Amps
- Hz
- kW
- Torque (vector regulation only)
- Selected reference (speed or torque)

To select a value to monitor, press the ENTER key until the LED turns on next to the desired display item. Pressing the ENTER key advances you through each of the displays.

Note: All of the LEDs turn on to indicate the selected reference display.

Figure 42, Example of a Monitor Mode Display



Displaying the Selected Reference

In monitor mode, you can display the speed reference (speed and frequency), or the torque reference the drive is using while it is running, (RUNNING LED is on, JOG LED is off). Follow these steps to display the selected reference:

Step 1 If you are not already in monitor mode, access it by pressing the PROGRAM key until the PROGRAM LED turns off.

Step 2 Press the ENTER key repeatedly to advance through each of the monitor mode LEDs. All of the monitor mode LEDs will then turn on at once and the reference will be displayed. Note that the displayed speed reference value is scaled based on P.028. The torque reference value is displayed in percent.

If the selected reference is negative, and its value is greater than 999, the SPEED LED will flash.

The Display

The display portion of the keypad/display is a four-character, seven-segment LED. At drive power-up, SELF is displayed as the drive performs power-up self diagnostics. During drive operation, the display indicates parameter numbers, parameter values, fault or alarm codes, and drive output values.

Display Range

Normally, a minus (-) sign is used as one of the four characters in the display to indicate a negative value. If a value (including the minus sign) exceeds four characters, the display will drop the minus sign and display four digits. In this case, the SPEED LED will flash to indicate that the displayed value is a negative number. Refer to the examples in the following table.

A decimal point to the right of the last digit in the display indicates there is further resolution (examples A and E below), unless a decimal point already appears as part of the number displayed (example G below). In either case, the system uses the full resolution of the number for drive control, not the displayed value.

Table 45, Display Range Examples

Example	If the actual number is …	It will appear on the display as …	And the SPEED LED will …
A	1000.5	1000	Not Flash
B	-999	-999	Not Flash
C	-1000	1000	Flash
D	-99.9	-99.9	Not Flash
E	-1000.5	1000	Flash
F	-9.99	-9.99	Not Flash
G	-100.25	100.2	Flash
H	-9.999	9.999	Flash

This does not apply for the speed display. For the speed display, the FORWARD REVERSE LEDs indicate actual speed reference polarity.

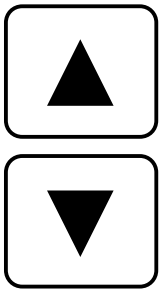
The Keypad

The drive's keypad has nine membrane keys that are used to monitor, program, and control the drive.

Use the AUTO/MAN key to switch between the auto speed reference and the manual speed reference as shown below.

AUTO/MAN Status	Control Source (P.000)	Speed Reference Source
AUTO Selected	Local keypad/display (P.000=LOCL)	Terminal Strip
	Terminal Strip Remote Inputs (P.000=rE)	Terminal Strip
	Option Port (P.000=OP)	Network
	Serial Port (P.000=SerL)	Terminal Strip

Note: Manual speed reference is not allowed on McQuay Centrifugal Chillers.



Use the ▲ and ▼ keys to:

- Step through the drive parameter menus and error log when the keypad/display is in program mode.
- Increase (or decrease) a numeric value (such as the reference or a parameter value).

Hold down these keys to increase the scroll speed.

Use the ENTER key to:

- Display a parameter (or a selection) value in program mode.
- Save a value.
- Move through each monitor display item when in monitor mode.

FORWARD / REVERSE

Use the FORWARD/REVERSE key to select the direction of motor rotation when the control source is local (REMOTE LED is off). This key is ignored if the control source is not local (REMOTE LED is on). See the FORWARD and REVERSE LED descriptions for more information.

Note: Local control source is not allowed on McQuay Centrifugal Chillers.

PROGRAM

Use the PROGRAM key to move between program and monitor modes. The PROGRAM LED turns on when the keypad/display is in program mode and turns off when the keypad/display is in monitor mode.

RUN / JOG

Use the RUN/JOG key to toggle between run and jog when in local control (REMOTE LED is off). When run is selected, pressing the START key results in continuous drive operation. When JOG is selected, pressing the START key results in drive operation only until the START key is released.

Note: **Do not run in local control. Do not JOG. Compressor may run without lubrication.**

This key is ignored if the control source is not local (REMOTE LED is on). See the RUN and JOG LED descriptions for more information.

START

Use the START key to apply power to the motor in local control (REMOTE LED is off). See the RUNNING LED description for more information.

Note: **Local control is not allowed on McQuay Centrifugal Chillers. Compressor may run without lubrication.**

STOP / RESET

If the drive is running (RUNNING LED is on), the STOP/RESET key stops the drive. If the drive is not running (RUNNING LED is off), pressing this key resets drive faults.

Using the LEDs

The keypad contains eight LEDs that show the present drive status. The following table describes what each drive status LED means.

Table 46, Drive Status LEDs

LED	LED Status	Meaning
RUNNING	On	Output power is being applied to the motor.
	Off	Output power is not being applied to the motor.
REMOTE	On	The drive is being controlled (START, RUN/JOG, FORWARD/REVERSE, speed reference) from a source other than the keypad.
	Off	The drive is being controlled from the keypad. (Not Allowed)
	Flashing	The network connection is lost.
JOG	On	(Not Allowed)
	Off	
AUTO	On	The drive is receiving its speed reference from the terminal strip input or network option.
	Off	The drive is receiving its speed reference from the local keypad or serial port (OIM or CS3000), i.e., using a manual reference. (Not Allowed)
FORWARD	Flashing	The requested motor direction is forward; the actual motor direction is reverse (REVERSE LED is on).
	On	The motor is running in the forward direction.
	Off	The motor direction is not forward.
REVERSE	Flashing	(Not Allowed)
	On	
	Off	
PROGRAM	On	The keypad/display is in program mode.
	Off	The keypad/display is in monitor mode.
PASSWORD	On	Parameters cannot be modified from the keypad without entering the correct password into P.051 (Programming Disable). Note that disabling program changes by means of P.051 does not prevent parameter changes being made from the serial port or the network.
	Off	Parameters can be modified from the keypad.

Table 47 describes the values that will be displayed when the corresponding monitor mode LED is on.

Table 47, Monitor Mode LEDs

Monitor Mode LED	Corresponding Display When LED Is On (Actual Values)
SPEED	Motor speed is displayed.
VOLTS	Drive output volts are displayed. This value is not DC bus volts.
AMPS	Drive output amps are displayed.
Hz	Drive output frequency in hertz is displayed.
KW	Output power of the drive in kilowatts is displayed. Note that this is intended for display purposes as a general indication of kilowatt output and should not be used for control or exact metering purposes.
TORQUE	Motor output torque is displayed in percent. (Valid only for vector regulation).
ALL LEDs	Selected speed reference or torque reference (in %) is displayed.

Troubleshooting

DANGER

DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or death.

The drive can display two kinds of error codes; alarms and faults, to signal a problem detected during self-tuning or drive operation. Fault and alarm codes are shown in Table 48 and Table 49. A special type of fault code, which occurs rarely, is the fatal fault code.

Alarm Codes

An alarm condition is signified by a two- or three-letter code flashing on the display. The drive will continue to operate during the alarm condition. The cause of the alarm should be investigated to check that it does not lead to a fault condition. The alarm code remains on the display as long as the alarm condition exists and clears when the condition causing it is corrected.

Fault Codes

A fault condition is also signified by a two- or three-letter code flashing on the display. If a fault occurs, the drive coasts to stop and the RUNNING LED turns off. The first fault detected is maintained flashing on the display, regardless of whether other faults occur after it. The fault code remains on the display until it is cleared by the operator using the STOP/RESET key or using the fault reset input from the selected control source.

Error Log

The drive automatically stores all fault codes for faults that have occurred in the system error log. The error log is accessible through the keypad or the OIM. There is no visual indication that there are faults in the log. You must access the error log to view the faults.

The error log holds the 10 most recent faults that have occurred. The last fault to occur is the first one to appear on the display when you access the error log. The faults in the log are numbered sequentially. The most recent fault is identified with the highest number (up to 9). Once the log is full, older faults are discarded from the log as new faults occur.

For each entry in the error log, the system also displays the day and time that the fault occurred. The day data is based on a relative 247-day counter (rolls over after 247.55). Scrolling through the error screens will give the day, for example, 117, which would be 117 days from the 0 day.

The time is based on a 24-hour clock. The first digits of the clock data represent hours. The last two digits represent minutes. For example, 10:17 PM would be 22.17. The clock can be reset using R030 (Elapsed Time Meter Reset).

See page 46 for details on adjusting the time stamp.

All entries in the error log and the day and time data are retained if power is lost.

Identifying Alarm Codes and Corrections

VFD drive alarm codes are shown in Table 48. Note that the alarm code will only be displayed for as long as the problem exists. Once the problem has been corrected, the alarm code will disappear from the display.

Table 48, List of Alarm Codes

Code	Alarm Description	Alarm Cause	Correction Action
Hldc	High DC bus voltage	The DC bus is charged above the trip threshold. (If U.018 > 415, DC bus is above 741 VDC. If U.018 ≤ 415, DC bus is above 669 VDC.)	Increase the deceleration time in P.0002, P.018. Install optional snubber resistor braking kit. Verify that the AC input is within specification. Install an isolation transformer if required. Check the actual line voltage against U.018.
I-Ac	V/Hz identification procedure active	V/Hz identification procedure is enabled and in progress.	Allow identification procedure to finish. Press keypad STOP/RESET to cancel identification procedure if desired.
I-En	V/Hz identification procedure enabled	H.020 = On; V/Hz identification procedure has been enabled but not started.	Proceed with V/Hz identification procedure, start drive and allow procedure to begin. Display will change to I-Ac when drive is started. Change H.020 to OFF to cancel identification and clear I-En if desired.
LIL	Low AC input line	AC input line is low. For SVC, indicates DC bus is being regulated. No corrective action is required.	Adjust line voltage parameter (H.021 or U.018) to match actual Ac line voltage.
S-Ac	Vector self-tuning active	Vector self-tuning is enabled and in progress.	Allow vector self-tuning procedure to finish. Press keypad STOP/RESET to cancel vector self-tuning procedure if desired.
S-En	Vector self-tuning enabled	U.008 = On; vector self-tuning has been enabled but not started.	Proceed with vector self-tuning, start drive and allow self-tuning procedure to begin. Display will change to S-Ac when drive is started. Change U-008 to OFF to cancel self-tuning and clear S-En if desired.

Note: Only properly trained and qualified service personnel should change the program or operating parameters.

Identifying Fault Codes and Recovering

DANGER

DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or death.

VFD drive fault codes are shown in Table 49. To clear a single fault that has occurred so that the drive can be started again, correct any problems indicated by the fault code and press the STOP/RESET key on the keypad, or assert the fault reset from the selected control source (P000). Because multiple faults can occur and only the first will be displayed, you must access the error log repeatedly in order to view all of the faults that have occurred and correct them.

Table 49, List of Fault Codes

Code	Alarm Description	Fault Cause	Correction Action
AIn	Analog input signal loss	P.011 = 4 or 5 and 4 to 20 mA analog input is below 1 mA.	Verify that P.011 is set correctly. Check that the analog input source supply ≥ 1 mA.
bYC	DC bus charging bypass contactor	Charging bypass contactor did not close or contact closure was not sensed by the system.	Check operation of the bypass contactor. Verify the contactor is closing when the proper bus voltage is applied. Replace contactor.
CHS	Default parameter restore (check sum error)	During drive operation: Regulator board failure. After: Regulator board replacement.	Contact McQuay or replace regulator board. Contact McQuay.
EC	Earth current failure (ground fault)	Unintentional grounding.	Check isolation between ground and output terminals. Possible leakage, current sensor defects; replace sensor.
EEr	Non-volatile memory write failure	Failure to write on non-volatile memory.	Connect CS3000 software to upload parameters or record by hand. Then replace regulator board. Parameter values will be lost when power is cycled.
EL	Encoder loss	Drive is not detecting feedback from the encoder.	Check the connection between the encoder and the drive. Check the encoder/motor coupling.
FL	Function loss	Function loss input on control terminal is opened.	Check external interlocks at terminals 16, 20.
Hld	High time identification aborted	Identification process for B/Hz has been aborted.	See H.019 for identification result.
HIL	High line voltage	Input voltage more than 15% above nominal.	Check actual line voltage against U.018 or H.021.
HU	High Dc bus voltage	DC bus voltage too high (capacitor protection). Deceleration time too short.	Check input line voltage; if necessary, add transformer. Increase deceleration time P.002/P.018/P.023 versus Maximum Speed/Hz (P.004). Install DB option with resistors.

Continued on next page.

Code	Alarm Description	Fault Cause	Correction Action
IPL	Input phase loss	Voltage ripple on DC bus due to missing input phase or an imbalance between phases. DC bus voltage too low. Line dip too long (P.042).	Verify that proper voltage is being applied to the drive. Check all phases. Check input voltage, line fuses. If necessary, add transformer. Check value of Ride Through Time (R042), Line Voltage (H.021, U.018). Check DC bus voltage. If incorrect, replace diode set. Check network cabling from network master to network option board. Check that network master is operating properly. Reset fault. Perform Identification Request. Restart drive.
LU	Low DC bus voltage	Input rectifier diodes defective.	
NCL	Network comm loss	Communications with the AutoMax network have been lost.	
Nld	Identification request not yet performed (V/Hz only)	Drive started but Identification Result = Zero.	
OC	Overcurrent (steady state) – Trips between 185 and 200% load (based on inverter type current) check power module rating	Output phase-to-phase short. Bus voltage line-to-line. Ground fault. Momentary overload. Bad motor. Torque boost / V/Hz too high (V/Hz). Motor unknown to regulator (V/Hz Parameter settings (vector). Encoder wired incorrectly, wrong PPR.	Check isolation between each output line. Check transistor modules for correct output. If incorrect, possible board defect; replace. Possible Hall effect current sensor defective; replace. Check isolation between ground and output terminals. Possible leakage current sensor defect; replace sensor. Check for motor overload; reduce load on motor. Check motor for correct operation. Check parameters H.001, H.002, and/or H.003. Enable Identification Request (H.020) Check that regulator was updated with actual motor characteristics via Identification Request (H.020). Check Encoder PPR (U.001), Motor Poles (U.002), Base Frequency (U.003), Motor Nameplate Amps (U.004), Magnetizing Current (U.006), Speed Regulator Prop. Gain (U.012). Check encoder wiring. Perform vector self-tuning.
OCA	Overcurrent (at acceleration)	Overcurrent condition occurred while accelerating. Acceleration time too short.	See OC fault corrective actions. Increase acceleration time (P00l, P017, P021).
Ocb	Overcurrent (at DC braking)	DC voltage too high.	Check parameters H.006, H.007.
OCd	Overcurrent (at deceleration)	Overcurrent condition occurred while decelerating. Deceleration time too short.	See OC fault corrective actions. Increase deceleration time (P002, P018, P022).

Continued on next page.

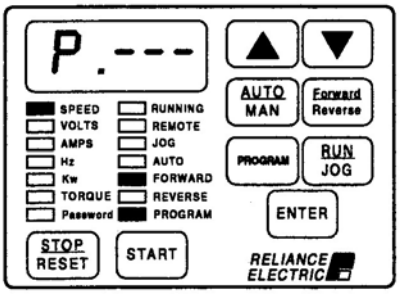
Code	Alarm Description	Fault Cause	Correction Action
OF	Overfrequency	Drive has exceeded maximum allowable output frequency. Regenerating energy is too high. Stability or slip compensation circuit adds frequency reference. If H.016 ON, searching current is too high. Motor is too small.	Vector: Check parameters Encoder PPR (U.001), Motor Poles (U.002), Base Frequency (U.003). V/Hz: Check DC bus voltage; increase decelerating time. Check values Max Speed (P004) Overfreq. (H.022). Check slip compensation (H.004). If H.016 ON, check motor size versus Power Module size, recheck setting of P005 (too high).
OH	Drive overtemperature	Cooling fan failure.	Check ambient temperature, cooling fan, minimum clearances around drive.
OL	Motor overload	Excess motor current. V/Hz: Torque boost too high, therm. overload level too low.	Vector: Check actual/Motor Rated Nameplate Amps (U.004) V/Hz: Check actual current/Torque Boost (H.003). Check that Power Module is sized correctly. Reduce load on motor (for example, at low frequency).
		Excess load on motor, for example, at too low speeds.	Check that Power Module is sized correctly. Reduce load on motor (e.g., at low frequency).
		Loss of phase connection.	Check output lines to the motor.
OPL	Motor output phase loss	Phase lost between drive and motor.	Check connections and cable of all 3 phases and motor windings. Replace any damaged cable.
OSP	Overspeed (vector only)	RPM above 130% Maximum Speed (P.004), speed regulator response not optimized.	Check Encoder PPR (U.001), Motor Poles (U.002), Base Frequency (U.003), Motor Nameplate RPM Speed (U.005). Check Reg. Proportional (U.01 2) Integral Gain (U.01 3)
PUc	Missing power module ID connector	Bad or disconnected cable between Regulator and Power Module.	Check cables between Regulator board and Power Module.
PUn	Power module not Identified	Drive parameters have been restored to power-up defaults. Regulator has not been configured to match Power Module.	Power Module must be configured by Reliance service personnel.
PUo	Drive power electronic overload	Power Module overloaded. Too high DC Braking Current (H.007) or Torque Boost (H.003).	Check load to Power Module. Check Power Module sizing versus application. Check DC Braking Current value (H.007). Check Torque Boost (H.003).
SF	Self-tuning status (Vector only)		See parameter U.009
SrL	Communication loss between regulator/PC/OIM	Serial Port communication cable, PC or OIM communication port setup.	Check connection cable and communication port setup.
UAr	Spurious host PC comm interrupt	Regulator board failure.	Replace Regulator board.
UbS	Asymmetrical bus charge	Bad Power Module.	Contact McQuay.

Note: If extensive troubleshooting or corrective actions are necessary, only properly trained and qualified technicians should be used.

Accessing, Reading, and Clearing the Faults in the Error Log

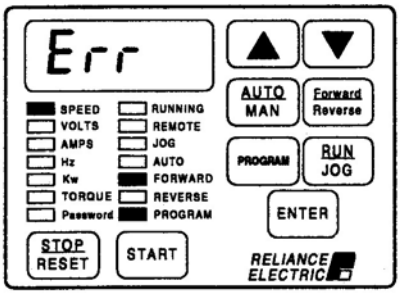
The following procedure shows how to access and clear the error log. Note that you cannot clear a single entry from the error log. The entire log, including all of the fault codes, and the day and time stamp of each fault, will be cleared simultaneously using this procedure.

Step 1. Press the PROGRAM key.

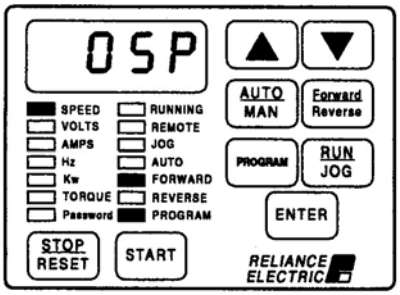


The First Menu General parameters are displayed. The PROGRAM LED will turn on.

Step 2. Press the ▼key until Err is displayed.



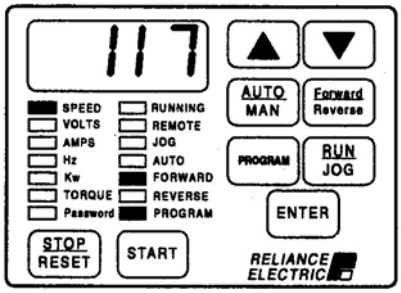
Step 3. Press the ENTER key.



If no faults have occurred, Err will be displayed again. If only one fault has occurred, the fault code will be displayed as the first entry in the log. If more than one fault has occurred, the first entry is the latest fault that occurred.

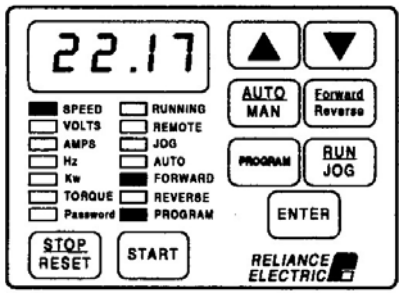
Step 4. Press the ▲ and the ▼ key. The display steps through the error log entries, which are numbered 0 through 9 (maximum).

Step 5. Press the ENTER key.



The display shows the day stamp, which can range from 0 to 248 days.

Step 6. Press the ▼key.

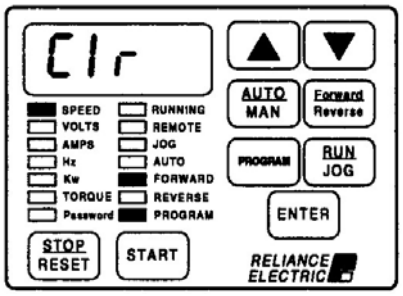


The display shows the time stamp, which is based on a 24-hour clock. Use the arrow keys to move between the day and time data.

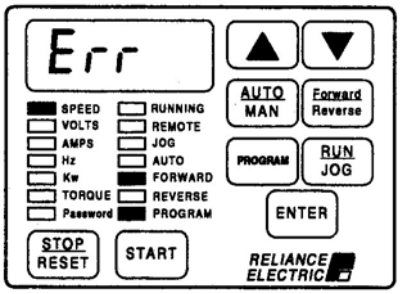
Step 7. Press the PROGRAM key, which displays the error log entries again. The display shows the error log entry viewed prior to, or associated with, the time stamp.

Step 8. Repeat steps 4 through 7 for each additional error log entry to view the time and date for each error log entry.

Step 9. When you have viewed all the entries, you should clear the error log. Press the ▼ key while you are viewing any entry in the log until the display shows CLr. Press ENTER to clear the error log. All entries will be cleared.



Step 10. Err will be displayed again to indicate that the log is empty.



Step 11. Press the PROGRAM key to access monitor mode.

Fatal Faults

Fatal fault codes are distinguished by the letter F preceding the code. They normally indicate a malfunction of the microprocessor on the regulator board. In some cases, fatal fault codes can be reset and the drive can be re-started. Table 50 lists the fatal fault codes that can be reset. If any other fault code appears on the display, the regulator board will have to be replaced.

If the fault code FUE appears in error log entry 0, it indicates a fatal fault occurred as power was lost. Contact McQuay International or observe the drive for subsequent fatal errors before turning off power. Fatal fault codes are lost after power loss.

Table 50, Fatal Fault Codes That Can Be Reset

Code	Fault Description	Fault Cause	Corrective Action
F 3	Encoder power-up diagnostic errors.	Encoder voltage is less than 10V.	Turn off power to the drive. Disconnect the encoder wiring from the terminal strip. Turn power to the drive back on. If the F3 error does not occur again, the problem is in the wiring between the drive and the encoder. If the F3 error does occur again, the problem is in the regulator board, which should be replaced.
F 60	Option port identification errors.	The option board could not be identified by the regulator.	Check the ribbon cable between the regulator board and the option board. Check the option board's jumper settings. Refer to the appropriate option board instruction manual for more information about the option board.
F 61	Option board power-up diagnostic failure.	Option board has failed one or more power-up diagnostics.	Check the ribbon cable between the regulator board and the network option board. Replace the option board if necessary. Refer to the appropriate option board instruction manual for more information about the option board.
F 62 Or F 26	Option board runtime errors.	During operation, the option board watchdog failed or handshaking with the drive failed.	If intermittent, check for causes of noise, for proper grounding, and that outputs are not exceeding rated current capacities. Replace the option board if necessary. Refer to the appropriate option board instruction manual for more information about the option board.

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